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Aaron L. Shalowitz, *Editor*

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Eighth Annual Meeting

JUNE 21, 22, 23—HOTEL STATLER—WASHINGTON, D. C.

Preliminary Announcement

THE EIGHTH ANNUAL MEETING of the American Congress on Surveying and Mapping is being planned for June 21, 22, and 23, 1948, at the Hotel Statler, Washington, D. C. The meeting this year has been extended an additional day to give members an opportunity to inspect the mapping facilities of Federal agencies located in the Washington area.

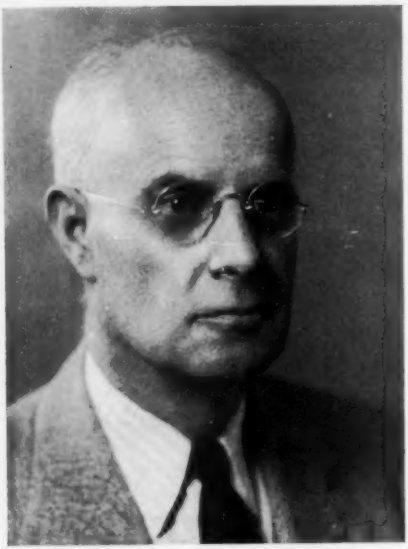
A broad program of special interest to surveyors, engineers, and professional men in the surveying and mapping fields is being arranged, and will include panel discussions on subjects of current interest, technical papers by recognized authorities, special meetings of the Technical Divisions, and an extensive exhibit of surveying and mapping equipment by both foreign and domestic manufacturers. A dinner with appropriate entertainment will close the meeting.

Further program details and arrangements for hotel reservations will be announced at a later date.

THE EXECUTIVE COMMITTEE

Our New President

MARSHALL S. WRIGHT, fifth President of the American Congress on Surveying and Mapping, was born in Toronto, Canada, December 28, 1890. He spent his early youth in Salmon, Idaho. After completing public schools, he attended the Toronto Polytechnic Institute and the Utah Agricultural College.



He entered the U. S. federal service in 1915 as a transitman with the General Land Office, and for 5 years was engaged on surveys of townships, base lines, and meridians, and on surveys of portions of the United States-Mexico boundary in southern California, the California-Oregon boundary, the Idaho-Montana boundary, the Utah-Idaho boundary, and the Idaho-Wyoming boundary. In 1919 he transferred to the Forest Service and was in charge of the Surveying and Mapping Section of the Regional Office at Ogden, Utah. In 1923 he was transferred to Washington, D. C., in the office of the Chief Engineer, where his duties were extended to cover all the surveying and mapping activities of the Forest Service throughout the United States and Alaska.

Mr. Wright left the federal service in 1929 for private employment and for several years was associated successively with the Aerotopograph Corporation, as sales engineer; with Fairchild Aerial Surveys; and with the Curtiss-Wright Flying Service, as project engineer. In August 1933 he returned to the Forest Service. Subsequently he was engaged in the administration of photogrammetric mapping activities in the Soil Conservation Service and in the Office of the Secretary of Agriculture, where he also served on the Technical Advisory Board as consultant and advisor. He is now technical assistant to the chief of the Office of Plant and Operations, and is responsible for the topographic, planimetric, and cadastral survey activities of all departmental agencies. As liaison officer to the Bureau of the Budget he advises on the surveying and map production techniques and methods of the Department.

Mr. Wright represents the Department of Agriculture on several official bodies, such as the U. S. Advisory Committee on American Cartography of the Pan-American Institute of Geography and History; the U. S. Board on Geographic Names; and the Research and Development Board, National Military Establishment, of which he is Chairman of the Panel on Cartography and Geodesy of the Committee on Geophysical Sciences.

His organizational affiliations include membership in the American Geophysical Union, serving as a member of the Committee on Surveys and Maps; the American Society of Photogrammetry (president in 1939); and the American Congress on Surveying and Mapping, of which he was regional vice president for 4 years. He is a member of the Cosmos Club at Washington, D. C.

A Message From President Wright

THE biggest job lying before the Congress this year is one of reorganization, i.e., the effectuation of the new Constitution and By-laws as approved at the Annual Meeting in August. The ground work is substantially laid; a new Board of Directors is being chosen by popular election.

As soon as the newly proposed Board of Directors is elected, the National Advisory Council, provided in Article V, paragraph 5 of the Constitution will be appointed. This Council will be "composed of one member of each of the States and Territories of the United States . . . having ten or more resident members. . . ." With the establishment of this group, the Congress with its new Board of Directors and a strong Publications Committee will be in shape to effectively attain its complete objectives as outlined in Article I of its Constitution, namely:

(*a*) To advance the sciences of surveying and mapping in their several branches, in furtherance of the public welfare and in the interests of both those who use maps and surveys and those who make them, and to establish a central source of reference and union for its members.

(*b*) To contribute to public education in the use of surveys and maps and to encourage the prosecution of basic surveying and mapping programs, especially those programs which are paid in whole or in part with public funds.

It is fully realized that the most important and the most vital link between the members and the organization is its publication, SURVEYING AND MAPPING. A new Publications Committee is being organized whose main and immediate objective will be to assist the Editor-in-Chief in preparing the Journal for publication, so that it may be issued regularly and on a quarterly basis. The Committee cannot effectively and entirely perform this function without the wholehearted support and the co-operation of the entire membership. It is urged that every effort be made to prepare, or otherwise obtain worthwhile, interesting articles and send them to the Chairman of the Publications Committee.

Your President fully appreciates the transitory nature of the position he occupies and realizes that without the support and the assistance he receives directly from the officers of the Congress and the inspiration accorded by the membership, his efforts would be of slight avail; and accordingly, so that a noticeable difference will be detectable within a comparatively few years of the status and prestige of our chosen profession, he asks that the Congress be given the full support of each and every member to the end that the surveying profession will attain its rightful place in the field of science.

MARSHALL S. WRIGHT
President

The Seventh Annual Meeting

THE Seventh Annual Meeting of the American Congress on Surveying and Mapping was held on August 14 and 15, 1947, in the Congressional Room of the Hotel Statler, Washington, D. C. Attendance at the meeting totaled 275, a most satisfying figure in view of the widespread geographic areas represented. Besides the United States, eleven countries were represented, including Canada, Mexico, Brazil, Bolivia, Chile, Colombia, Cuba, Peru, Venezuela, Sweden, and Switzerland.

General Sessions

The meeting was opened by George D. Whitmore, past president, in the absence of President Borden, who is on sea duty, and acting president Marshall Wright, who at the last minute was called to attend the British Commonwealth Survey Officers Conference as a part of the American delegation. Mr. Whitmore read a telegram from President Borden from Attu, Alaska, extending best wishes for a successful meeting.

The first day's sessions were devoted primarily to two panel discussions. (A verbatim transcript of both panels has been made and will be furnished to the membership in mimeographed form.) The first was on "Surveying and Mapping Curricula as Taught in our Colleges and Universities Today—Tomorrow." Participants in the discussion were Talbert Abrams, of Abrams Aerial Survey Corporation; S. A. Bauer, civil engineer and surveyor of Cleveland; Prof. G. Brooks Earnest, of Case Institute of Technology; Virgil Kauffman, of Aero Service Corporation; J. L. Rannie, Dominion Geodesist, Geodetic Service of Canada; and George D. Whitmore, of the U. S. Geological Survey. Prof. George H. Harding of Ohio State University acted as moderator.

The panel discussion was arranged in the form of definite questions which each member of the panel had an opportunity to answer. The replies of the panel members were then supplemented by audience participation. The discussion brought out a strong variance of opinion on questions as to whether college courses had kept pace with development and equipment, the value of campus surveying in addition to summer practice, the prospect of granting a degree in photogrammetry, and the additional prospect of a specialized course in surveying and mapping with or without a degree under that title.

The second panel dealt with "The Fundamental Principles for Determining the Amounts of Fees and the Methods of Charging for Survey Work." Members of this panel were: Ford Bartlett, of Lockwood, Kessler and Bartlett, Inc., Brooklyn; Charles A. Cahn, civil engineer, of New Haven; Wilson Forrest Daniell, of The Texas Company; Major Herbert Hartman, of Clarke and Hartman, Jersey City; and E. H. Owens, Owens Engineering Company, Kansas City. The moderator was S. A. Bauer of Cleveland, Chairman, Property Surveys Division, ACSM.

The discussion was conducted by first having each member present his views and then by a discussion from the floor. The speakers stressed such matters as the importance of professional recognition from each engineer's colleagues and from those to whom he provided services; the need for building strong, unified organizations of engineering concerns in communities, with a stable fixed rate

structure as a foundation; the importance of property surveyors' making a conscientious effort to search out all information, provide a free interchange thereof, and maintain moral and business responsibility; the vital relationship of surveying to law; and the importance of the community services rendered by the surveyor. On the question of fees, opinions were expressed that rates for lot surveys should be on a square footage basis and on a per diem basis for industrial areas, and that land values should be a factor in rate determination.

The first day's session closed with a demonstration by Charles R. Manor, Engineer Board, Corps of Engineers, U. S. Army, of the first American-made 10-second optical-reading theodolite. He also described the extensive tests made with the assistance of the U. S. Coast and Geodetic Survey in proving the accuracy of the instrument.

Following the business session on the morning of the second day, the members heard an unscheduled report by Dr. Andre Simonpietri on the approaching Pan American Conference on Cartography to be held in Buenos Aires on April 11–30, 1948. He was introduced by Mr. Robert H. Randall, who presided for the remainder of the morning session. Dr. Simonpietri reviewed the anticipated complete study and exhibit of cartography at the Conference, with important reports to be made on photogrammetric equipment and reproduction processes. The Conference will be broadly representative of many nations.

The session next heard from Dr. Jorge Zarur, Assistant Secretary-General of the National Council on Geography, Brazil. Dr. Zarur described his extensive journey throughout Central and South America to prepare a preliminary report in connection with the proposed 1950 census sponsored by the Inter-American Statistical Institute. His trip revealed that the activities of the Commission on Cartography of the Pan American Institute on Geography and History had provided stimulation of the cartographic interest of each country, but that extensive mapping was delayed by lack of a systematic program, trained personnel, and reproduction materials.

Upon the conclusion of Dr. Zarur's talk, the chairman briefly discussed the Inter-American Geodetic Survey.

The morning session was concluded with a paper on "The Land Surveyors Social Role," delivered by L. Germain Gastonguay, Member, Board of Direction, Corporation of Quebec Land Surveyors, Canada. He cited the definite relationship between land division and the everyday necessities of life.

The second afternoon and final session began with a showing of a portion of the color training film, "Topographic Mapping by Photogrammetric Methods." The production of the film was sponsored by the Commission on Cartography of the Pan American Institute on Geography and History and the U. S. Geological Survey. The reel shown was that picturing the multiplex process. It was announced that the film would be available from the U. S. Geological Survey for showing within the United States.

The concluding presentation of the Seventh Annual Meeting was a discussion of "Electronic Developments" by S. W. Seeley, Director, Industry Service Laboratory, Radio Corporation of America. He was introduced by Col. C. I. Aslakson of the Army Air Forces. Mr. Seeley described some simple forms of Radar, the design of Shoran equipment, compared Shoran and Loran as electronic yardsticks, and treated his listeners to prophecies of future electronic marvels.

Business Session

The annual business meeting of the Congress was held on the morning of the second day and was presided over by Mr. Whitmore.

The Acting Executive Secretary, Walter S. Dix, reported on the activities of the Congress during the past year, and the Treasurer, Richard T. Evans, reported on the financial status of the Congress. (Both reports are published elsewhere in this issue.)

A brief impromptu report on the status of Surveying and Mapping was given by the Editor, A. L. Shalowitz. He mentioned two factors which would determine the regularity and frequency of the appearance of the Journal; distribution of the present work load involved in preparing the Journal for publication, and building up and maintaining a backlog of 16–20 articles ready for publication. Until we have successfully coped with these two problems, he stated, the Journal will have to be published at irregular intervals.

Technical division and committee reports were given by S. A. Bauer, Chairman, Property Surveys Division; Comdr. H. W. Hemple, Chairman, Control Surveys Division; Albert Nowicki, Chairman, Membership Committee; Helmuth Bay, Chairman, Constitution Committee; and Prof. George H. Harding, Chairman, Prize Contest Committee. (Several of these reports are printed elsewhere in this issue.)

R. L. McCammon, Chairman, Tellers Committee, reported on the results of the election for President. Out of 426 votes cast, Mr. Marshall S. Wright received 417, thereby becoming the new president of the American Congress on Surveying and Mapping.

Mr. Whitmore then read the results of the recent letter ballot on revision of the Constitution and change in annual dues. Both majorities were in the affirmative, thereby placing in effect the revised Constitution and increasing the dues from four dollars to five dollars per annum.

The next topic of discussion was the proposal for a joint annual meeting in 1948 of the American Society of Engineering Education and the Congress. No final action had yet been taken, but all comments on the proposal are favorable.

The chairman then called upon Mr. Daniel Kennedy to say a few words concerning the Washington, D. C. Local Section of the Congress. Mr. Kennedy described the progress of the Section and stated that all members of the Congress residing in metropolitan Washington and in Baltimore were eligible for membership in the Section. A local section, he said, provided an opportunity to discuss the current problems of surveying and mapping which were too numerous to allow for complete treatment at a national conference.

Evening Dinner

The annual dinner was held in the South American Room of the Hotel Statler on the evening of August 14. During the dinner, music was provided by Jack Morton's orchestra. After dinner, the assembled guests were entertained by Mr. and Mrs. Harlan Randall with vocal selections, Harry Baker with feats of magic, and Brooke Johns in "Anything Can Happen."

Mr. Murray Y. Poling and his committee were thanked by the chairman on behalf of the Congress, for the excellent program and arrangements. They were enthusiastically applauded by the assembled guests.

Instrument Exhibit

This year's exhibit of surveying and mapping instruments and appurtenances was again a feature of the meeting. The displays, which held the prolonged attention of the attendant members and guests, were provided by the following sponsors: C. L. Berger & Sons; Brunson Instrument Co.; Keuffel & Esser Co.; W. & L. E. Gurley; Air Survey Corporation; Henry Wild, H. F. Ritz, agent in U. S. A.; Wallace and Tiernan Products, Inc.; David White Company; Submarine Signal Company; and The Engineer Board, Corps of Engineers, U. S. Army.

Alfred C. Stiefel
Francis L. Witkege

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Preliminary Report on Employer Practices

"A well-rounded-out individuality with a good personality, qualified by education and experience, will make a good engineer."

That, it would seem is what employers seek in engineering college graduates when they interview them as prospective employees, according to a report on a preliminary survey of employer practice regarding engineering graduates, which has just been made public by a subcommittee of Engineers Joint Council.

The object of the survey is to learn directly from a representative group of industrial employers their attitudes and policies regarding selection, training, placement, advancement, guidance and professional activities of engineering graduate employees. The results recently made public by the committee are of a preliminary character and are based on questionnaires sent to 174 employers of engineers, from whom 104 replies were received. The replies came from employers which employ some 40,000 engineers among a total approximating 2,000,000 employees.

Ninety-six percent of cooperators employ cadet engineers directly upon graduation, but only 4 percent recruit engineering staffs exclusively from new graduates. About 43 percent engage more than half of their new engineer employees after they have had one or more years' experience with other employers. Seventy percent send representatives to engineering schools to interview students individually. Nearly all of these discuss the candidates with members of the college faculties, in addition to interviewing the students. Only 25 percent of those reporting do not differentiate between engineers and other employees in the process of hiring. Only two companies report that engineers are employed without meeting at least one executive engineer.

From a statistical analysis of the replies, weighting the first, second, and lower choices in the way that preferential ballots are usually counted, the considerations which carry the most weight in selecting a candidate for an engineering position, in the order of their importance, are as follows:

1. Personality.
2, 3. Scholastic record. Indicated promise of development in specific field of engineering.
4. Engineering experience.
5. Evidence of ability to co-operate with others.
6. Recommendations by qualified people.
7. Indicated promise for executive development.
8. Standing of college from which candidate was graduated.
9. Salary requested.

The preliminary survey contains much additional information of interest and value to the younger engineer. Reprints of the preliminary report are available at ASCE headquarters upon request.—*Civil Engineering*, April 1947.

Professional Organization

By BRIGADIER M. HOTINE, C.B.E.
DIRECTOR, COLONIAL SURVEYS, BRITISH EMPIRE

As an observer from the United States to the Commonwealth Survey Conference held in London August 18–29, 1947, I had the pleasure of hearing, among other excellent papers, the one by Brigadier Hotine. The paper evidences the prestige and high esteem in which the surveyor is held throughout the United Kingdom and gives in considerable detail the educational background and the training essential to receive recognition in this specialized field of engineering. These should be of interest to our membership.

MARSHALL S. WRIGHT
President

I SHOULD make it clear at the outset that what I have to say refers in some respects primarily to the profession of land surveying in the Colonies. But I venture to think that it may also have some bearing on other Commonwealth territories; and in any case nothing should be done, nor do I propose anything, which might weaken the increasing collaboration between all parts of the Commonwealth which our periodic conferences and the establishment of the Empire Survey Review have done so much to promote.

It will be generally agreed that demands on the profession are now far greater everywhere than ever before. The voices which cried for so long in the wilderness have been heard. It is accepted that good surveys are essential for orderly administration and economic development; and advances in technical procedure have also made it possible for surveys to precede their main uses instead of, as so often in the past, panting along aimlessly behind them. We may not yet have all the money we could use, and our methods are certainly still far short of perfection, but at least and at last we have a full opportunity to get on with the job.

Are we organized as a profession to meet these increased and wider demands? I suggest not, not in the least.

In the first place a clearer formulation of the scope and functions of land survey organizations is desirable, which on the one hand make the most effective and economical use of their highly specialized scientific training and equipment; and on the other hand fit harmoniously into the general framework of administration. This need must be recognized but need not be explored here. In the second place, on any showing our ranks are depleted, and we cannot at present recruit enough of the right types to fill them. We could no doubt meet this situation by lowering standards of professional qualifications, and indeed this has been suggested. I am going to propose that we do the exact opposite and raise them, but at the same time make them more realistic.

We need men of highly scientific general education to conduct effectively the highly scientific and complex operations of modern surveys, and the need is perhaps greatest in new countries. But there is, and will always be, difficulty in attracting such men in sufficient numbers if opportunities and prospects comparable with those open to men of the same caliber in other professions are not offered. This vicious circle must ultimately be broken somewhere. Meanwhile, if those with the wedding garment of a good university degree—or those

who wish to concentrate solely on other wedding garments—will not come to the feast, then let us get surveyors from the highways and byways. But professionally qualified surveyors at least they must be; good surveyors, with powerful digestions, the right blood count, and a full house of *ad hoc* qualifications. Finally let us make it easy for such men to get qualified; without standing in queues or arriving by accident, self-taught through a back door. Initial educational qualifications are important but they are not in themselves sufficient.

Nor is initial professional qualification sufficient. Methods, and the balance of methods, are changing fast and we shall hope to make them change even faster. In addition, our spheres of interest are broadening, and most Commonwealth land surveyors are recognizing more and more the need for a wider understanding of the use and valuation of land in agriculture, forestry, in town and country planning, etc. We need a professional society to keep us up to date; to serve as a central forum for discussion, a clearing house of professional information, a meeting place for land surveyors home on visits or on leave, and a lead-in to allied subjects. This society should set and maintain the standard of professional qualification and regulate the professional conduct of its members; as indeed is the case of every other profession of honor and standing in the civilized community, which in turn requires the protection afforded by such a society.

I have no doubt it will be said that the root of our present difficulties lies deeper and beyond the reach of these simple and obvious eradicators. We already provide a good deal of "help and ornament" and in return receive too little "countenance and profit." This is so, and it is most regrettable that appreciation of land survey and the standing of land surveyors in some Commonwealth territories is still so low and in some cases is sinking even lower. But I suggest that it is not within our power to command "countenance and profit." We can, however, earn them.

In this connection, I cannot do better than quote some words of Sir Ernest Dowson in an earlier paper on the same subject:

> The status of the members of any profession and the advancement of their interests depend in the long run upon the value and scope of the work performed and the degree of public recognition accorded it. Thus in medieval times, when the practice of medicine was crude and its range limited, the leech held a humble place in society while the functions of the surgeon were performed by the barber. Slowly but steadily the value and scope of the work performed by physicians and surgeons increased with accumulating experience, scientific knowledge, and skill; while the status of the profession and the emoluments gained by its successful discharge mounted simultaneously. So that today the status of the medical profession, disregarded and despised a relatively few generations ago, is now looked up to little, if at all, less than the more time-honored callings of statesman, soldier, sailor, and lawman; while in financial rewards and in collective influence it is only surpassed by the latter. This revolution in public regard would not have been possible if the quality of the service the medical profession gives had not undergone transformation; nor have been attained if the members had not banded themselves effectively together as a professional body. But the greatest benefit that has been rendered, even in the narrowest sense, to the members of the profession by their corporate influence has not been the defense of the individual interests of the members, proper and necessary as this has been; but the vigilant regard that has been maintained of the public duty to the performance of which the profession is dedicated. Organizations like the British Medical Association, by maintaining touch with the requirements of Public Health

in all parts of the British Empire and by exerting a wise influence in promoting salutary measures and the employment of men of high scientific attainments both at home and abroad, have done much more to further the private interests of members of the medical profession than any narrower and more selfish concentration upon the promotion of those interests could have attained.

I could not agree more; and I trust you also will agree in placing the cart of "countenance and profit" behind the horse of public service.

So much for principles.

Now let us examine the proposed remedy in rather more detail. And above all let us be practical.

A Professional Society

In all, the Colonial Survey Services require about 300 *fully qualified* land surveyors of whatever race or creed. Numbers may well increase considerably as development proceeds, but no forecast of this can be made. The Ordnance and the Military Survey Service may require another 200. There are, and probably always will be, fewer in private practice. We may hope that some of the other Commonwealth nations, particularly those who do not run their own society, would provide some, possibly many, members in order to make existing contacts still stronger and still more continuous. But here again no forecast is possible. A central society would of course have to prove its value to the profession as a whole to retain, as well as initially to attract, the membership of land surveyors, particularly of those living and working overseas. Whatever the actual total field for membership, it seems unlikely that this could be large enough to stand entirely alone; to own suitable buildings and to provide permanent staff for, in the case of many members, very intermittent even though essential use. Nor is this course desirable if we can gain the benefits of, and add our own strength to, an existing society which is able and willing to provide for our needs.

There is another practical difficulty in the way of establishing a separate society in that one exists already, The Royal Institution of Chartered Surveyors, whose charter includes responsibility for advancing and facilitating the acquisition of knowledge relating to "the science of admeasuring and delineating the physical features of the earth." This clearly and completely covers our present object. But successful association with the Royal Institution will require ability on their part to satisfy our technical and professional needs fully; and on ours, understanding and acceptance of the obligations, as well as the benefits, of joining a wider professional family.

I have reason to believe that The Royal Institution would welcome a broader discharge of its responsibilities in relation to land surveying and a fuller membership of qualified land surveyors. To do this would necessitate the introduction of an alternative series of professional examinations, which the Institution would accept as qualifying for membership and which we could accept as qualifying for employment. For a start it would be necessary to admit leading and obviously qualified members of the profession without examination; but ultimately, entry both to the Institution and to practice should be solely through the standard examinations. We might expect that the Institution would admit us to its counsels on a level with its other constituent professions; would broaden its library and extend facilities for use and for discussion. The Institution might also in due course take over the Empire Survey Review as an

alternative professional Journal and arrange for editing in conjunction with allied secretarial duties. I believe all this can be agreed, either now in principle or left for your representatives to arrange.

I should like to interpolate here a word about The Royal Geographical Society, which has always included many land surveyors among its Fellows and which has frequently offered us the hospitality of its House and of its Journal for technical discussion. I believe I shall be echoing your views in expressing appreciation of this attitude and the hope that it will continue. There will always be a large field of common interest among geographers, explorers, and land surveyors. In my view this will not, and certainly need not, be affected by professional membership in The Royal Institution of Chartered Surveyors, an organization which can, within the framework of its existing charter, provide us with greater professional facilities and closer contact with allied professional interests previously mentioned.

So far, discussions have necessarily been informal. Before any of this can be done, there must be agreement among ourselves that this course is generally acceptable and will meet with your support if satisfactory arrangements on the broad lines proposed can be made by accredited representatives with The Royal Institution of Chartered Surveyors. If you do agree, and I hope you will, then I suggest you express your agreement and provide for appropriate representation by resolution.

Qualification

The Syllabus

A draft graduated syllabus of examinations has been drawn up after some preliminary discussion and is appended to this paper. Although a radical departure from precedent, I believe it would be generally acceptable to The Royal Institution of Chartered Surveyors, provided it also meets with your agreement.

The First Examination is designed to ensure that the candidate has a sufficient minimum general educational background to proceed to the higher technical subjects. The general level in mathematics and physics would be about that of the Higher School Certificate; which, or the equivalent of which, might exempt in the same subjects. The level in technical subjects would be about that required for surveyors' assistants, and it is possible that some use could be made of the examination machinery for testing such non-professional grades.

There has been some difference of opinion in the preliminary discussions as to whether academic and cognate subjects should be included in the Intermediate and Final Examinations and it has eventually been agreed, subject to your observations, to exclude them. In my view, this is correct. Unnecessary examinations should be avoided, and to the exact extent that a knowledge of academic subjects is necessary for the present purpose, it will be implicit in the professional subjects. For example, it would be impossible to pass the Final Examination in geodetic surveying without a considerable knowledge of mathematics, which would be far more than is required by the specialist cadastral surveyor. A compulsory paper in mathematics to meet both requirements would be impossible and unnecessary. A knowledge of such cognate subjects as valuation and town planning is unnecessary for the rank and file of the profession and should accordingly not form part of a minimum qualification; any more for instance than chemistry, of which surveyors at times find it necessary to acquire

some knowledge. It would be better to rely on facilities provided by the Institution to acquire some knowledge of such cognate subjects by those particularly requiring it and over a long period. Surveyors who have a wide academic background (e.g., a university degree) and a knowledge of cognate subjects can expect to derive some later advantage, if indeed they have profited by it, without the necessity to make all the rank and file of the profession possess such valuable, but additional, qualifications.

Another principle in designing these examinations has been recognition of the fact that fairly early specialization in the higher branches of one of the main subdivisions is necessary and is in fact the general rule. An incentive to do so has been provided in the Final Examination. But this in turn has required the Intermediate Examination to cover a very wide field so that a surveyor who passes this can actually be employed on anything without the necessity to learn "on the job" and usually at the expense of the job. This course also avoids the dangers of specialization on too narrow a foundation. In the result, both examinations are decidedly stiff. But in view of the high cost and disproportionate effects of inexpert or inaccurate surveys, this is not considered unreasonable.

The other main development is the inclusion of some knowledge of land registration as compulsory. Land registration is the complement of cadastral survey on the bookkeeping side, and its functions and features should be fully understood by every cadastral surveyor. But, as in other branches, arrangements must be made for the publication of special textbooks to make this knowledge easier to acquire than is the case at present.

Application

It would be proposed, after a reasonable interval, to make the Intermediate Examination an essential qualification for entry to the professional grades of the Colonial Survey Services; and to make the Final Examination an essential qualification to pass some bar or promotion in the scale. It is not, of course, possible to obtain official approval for this until the whole scheme has crystallized, but I should anticipate no difficulty. In general these proposals amount to tightening the present conditions in the direction of more solid professional knowledge and an incentive towards continuing professional studies during practice; and this should be considered all to the good. For the same reason it would be hoped that those Colonies which at present apply special conditions would agree to sink them and to accept this higher standard as sufficient, except possibly for some additional test in the local application of general knowledge, such test to be applied during the probationary period. Some part of these examinations, provided the land laws of the particular territory have been taken, might also qualify for a license in Colonial territories. There are very obvious advantages in adopting standard tests set by an outside body to a prescribed standard for all these purposes, and acceptable in all Colonies. If you do not think the proposed standards will do this, I hope you will suggest amendments.

We may hope too that some other Commonwealth nations would similarly accept something like these tests as equivalent to their own. *Per contra,* it should not be impossible to agree Commonwealth equivalents conveying exemption so that we may have the benefit of your closer professional association through membership to the same Institution. This is not an essential part of the scheme, but a valuable possible extension of it.

The Military Survey Service will, I am sure, appreciate the advantages of adopting common standards and of close association with the civil profession from which it must derive expansion in emergency; and will no doubt consider adopting these tests for qualification, pay, or promotion.

On the other side, eligibility for membership of the Institution would fall naturally into the present rules, viz., for students, First Examination; for probationers, Intermediate Examination; for professional associates, the Final Examination if also engaged in approved professional work; and for fellowship, a minimum age limit of 30 years and more responsible professional occupation in addition.

Draft Syllabus of Examinations

FIRST EXAMINATION

Chain Surveying and Leveling (Elements of)

Standards and instruments for lineal measurements—chains, tapes, rods.

Chain surveying for plans of small open areas and private estates; underlying principles; choice of stations and survey lines; permissible errors in chaining; obstacles to alignment and measurement; chaining on slope; entry in field-book.

The compass, optical square, clinometer, and box-sextant.

Bearings—true, magnetic, and grid.

Measurement of buildings and building sites for block plans, etc.

Plotting the field notes.

Computing areas.

Use of the principal types of surveyor's level; sections and spot levels; level-book entry and reduction; plotting sections.

Mensuration and Trigonometry

Lineal, square, and solid measures; the mensuration of lines, such as perimeters and diagonals of common figures; the calculation of areas; the contents of solid bodies; the application of the principles of mensuration to problems met with in professional practice, such as rainfall, drainage, ventilation, earthwork, and builders' work.

The elements of trigonometry so far as required for simple land surveying; plane trigonometry applied to the mensuration of heights and distances; the nature and use of the common system of logarithms.

Draftsmanship

Drawing instruments and appliances—their nature, use, adjustment, and preservation; the scales generally used in the preparation of drawings of land and buildings; the construction of scales; the sizes and descriptions of drawing and tracing papers in common use.

Freehand sketches and drawings to scales; orthographic and isometric projection of simple geometrical objects; accuracy tests in the drawing of plane patterns, etc.

Finishing of drawings—inking, hatching, lettering, and coloring.

Scaling from drawings for the purpose of calculating and computing areas and volumes; correcting errors caused by an incorrect scale; methods of enlarging, reducing, photo-copying, and reproducing.

Lettering—all cases in pencil and in ink.

Map Reading

Definitions; conventional signs on large and small scales.

Grid reference systems.

Use of protractor, map scales, and representative fractions; construction of bar scales.

Points of the compass—grid north and map setting; use and errors of the prismatic compass.

Intersections, back bearings, and resections.

Relief, contours, slopes, and gradients; intervisibility.

Mathematics

To Higher School Certificate standard.

Physics

To Higher School Certificate standard.

INTERMEDIATE EXAMINATION

Candidates must satisfy the examiners in all of the following three branches.

Cadastral Surveying and Land Registration

Use, adjustment, and limitations of all necessary instruments for minor traverse and minor triangulation.

Measurement and reduction of base lines by surface taping.

Azimuth from sun or stars; limitations and use of theodolite compasses.

Tacheometry and subtense measurement.

Spirit leveling and other methods of leveling and contouring for engineering and property surveys.

A knowledge of the comparative properties, and use, of the common surveyors' projections, but not their mathematical derivation; correction of scale, area, and bearing projection error; measurement and computation of areas.

Setting-out of works, estates, and new townships; road and railway alignment.

Beaconing and survey of small and large estates by traverse and minor triangulation; breaking down of major framework surveys; choice of methods and standards of accuracy; field recording and office reduction; checks.

Re-establishment of beacons from survey records; revision of large-scale maps and plans.

A general knowledge of the objects, evolution, and processes of land registration.

The candidate must produce a certificate from a recognized instructor or head of a survey department, to the effect that he has successfully carried through the survey of a medium-sized estate, or similar area, without assistance other than from manual labor, either in practice or while under instruction.

Topographic Surveying

Detail, traverse, and triangulation survey by planetable, on scales not smaller than 1:25,000, including the use and adjustment of simple and tachymetric alidades, compass, and clinometer; in addition to the written examination the candidate must submit a certified original or copy of a small planetable survey made by the candidate either in practice or while under instruction.

Topographic control for planetable or topographic air surveys; minor triangulation

and traverse; barometer heights; heights by vertical angle and air-photo distance; identification of control on air photos.

Elementary perspective; graphical plotting from vertical air photographs; slotted template assemblies; contouring between close height control with simple stereoscopes.

Plotting of grids, graticules, and control; compilation of air photo plots and plane-table sheets; fair drawing of maps; an elementary knowledge of comparative conventional signs and methods of depicting relief.

Revision of topographic maps.

An elementary knowledge of methods of map reproduction.

Geodetic Surveying

Methods of reconnoitering; beaconing, measuring, and recording geodetic base lines; primary triangulation; precise traverses; and geodetic levels.

Computation on the spheroid and on plane surveyors' projections of lines not exceeding 60 miles in length and triangles of side-length not exceeding 60 miles, but excluding the mathematical derivation of formulas.

FINAL EXAMINATION

Candidates must satisfy the examiners in *one* of the following three branches, and must have had 4 years' approved training covering one of the groups, 2 years of which must have been spent in practical training of a professional character in an office or appointment approved by the Council.

Cadastral Surveying and Land Registration

A more detailed knowledge of the subject matter of the Intermediate Examination in cadastral surveying, including the solution of unusual problems arising in property surveying.

Principles, adjustment, and use of air-photostereoscopic measuring instruments and machinery for detail plotting on close ground control.

Drawing, photography, and reproduction of maps in sufficient detail to decide methods and fully supervise the work.

A general knowledge of the operation of land registration throughout the world; a sound working knowledge of the land laws, customs, and tenure, and the operation of land registration, in any one British Commonwealth territory at the choice of the candidate.

Topographic Surveying

A more advanced knowledge of the subject matter of the Intermediate Examination in topographic surveying, including planetabling on small scales. The candidate must submit a small planetable survey certified as made by himself on any scale between 1:100,000 and 1:250,000 inclusive.

Principles and practice of controlling air photo compilations by Radar measurements to or from aircraft in flight, excluding detailed knowledge of ground and air sets, but including full knowledge of reduction and use of Radar measurements for air surveys.

Principles, adjustment, and use of stereoscopic measuring instruments and machinery on sparse ground control and for detail plotting.

Projection and design of topographic sheets and series.

Drawing, photography, and reproduction of maps in sufficient detail to decide methods and fully supervise the work.

Geodetic Surveying

The papers set in this branch may include questions which involve a fair knowledge of mathematics, including spherical trigonometry, differential and integral calculus, differential equations and analytical and differential geometry.

In addition to more advanced knowledge of the subject matter of the Intermediate Examination in geodetic surveying:

Geodetic astronomy; field observations and reduction of precise measures of latitude, longitude and azimuth, including the theoretical basis of methods and derivation of formulas.

The elements of gravity and magnetic surveys.

Computation on the spheroid and on plane surveyors' projections of primary triangulation, precise traverses, and geodetic levels, including the theoretical basis of methods and the derivation of formulas; adjustment of observations and of simple figures; weighting of observations.

Computation of long lines on the spheroid and on surveyors' projections with particular reference to Radar distances.

A general knowledge of methods for determining the shape and size of the earth, excluding methods based on gravity determinations.

* * *

Chair of Land Surveying at University of Cape Town

DURING LAST YEAR the University of Cape Town established a chair in Land Surveying. This is the first chair in Land Surveying in Southern Africa and therefore marks a step forward in the training of land surveyors. Thus a profession which has been recognized by Government since 1902 was, in 1946, recognized by a University as being the practice of a specialized subject and not a branch of engineering. In this matter Dominion universities have proved themselves to be many years behind European universities.

In 1930 the University of Cape Town first provided a degree course in land surveying. There was at that time no full-time lecturer in land surveying, and lectures in the professional subjects were given by the late Dr. van der Sterr, the late Mr. O. A. E. Schreiber, and Mr. Whittingdale. In 1932 three students graduated as bachelors of science in land surveying. In 1946 one of these graduates, G. H. Menzies, was appointed first Professor in Land Surveying at the University of Cape Town.

Since 1930 the land survey course has shown marked expansion. In that year it occupied one room at the University, and one room at the Trig-survey Office, Mowbray—now it spreads over nine rooms at the University. In 1935 there were two full-time lecturers and in 1947 the full time staff comprises a professor, senior lecturer, junior lecturer, and scientific instrument maker. In addition there are three part-time lecturers and two temporary lecturers. In 1930 there were 3 students—in 1947 there are 123.—*The South African Survey Journal*, June 1947.

A Practical Accuracy for Property Surveys

By S. A. BAUER

REGISTERED CIVIL ENGINEER AND SURVEYOR, CLEVELAND, OHIO

"ACCURACY" is defined ordinarily as "freedom from error." Since no observation can be entirely free from error, no observation can be entirely accurate. The word "accuracy," in its technical sense, is a relative term.

Surveys may vary from the most rudimentary reconnaissance surveys to detailed geodetic surveys of the highest precision. Each has some order of accuracy. The task of the practicing property surveyor is to determine a working accuracy at some point in between these extremes, since the reconnaissance survey is of much too low an accuracy to have any value in the determination of property lines, and geodetic methods are too costly and slow for the average property-line survey.

Available information on property-line survey accuracies is inconclusive. American Society of Civil Engineers Manuals No. 10 and No. 20 treat on the subject. These manuals recommend second-order accuracy for the control surveys from which property-line surveys are made. Manual No. 20 defines the order of accuracy for such control lines as follows:

> Closures of 1/10,000 after angle adjustment shall be obtained in rural areas; closures of 1/20,000 after angle adjustment shall be obtained, where property value amounts to $75.00 or more per front foot.

If the control for a property-line survey requires top accuracy of 1/20,000 (position closure), we may assume that the property-line survey itself requires a somewhat lower accuracy (the value of which is not stated in this document).

Among textbooks on surveying, recommended accuracies for property surveys vary from 1/5,000 to 1/40,000 in loop closure.

Most governmental agencies' specifications for property-line surveys call for an accuracy of 1/10,000 in loop closure.

The Technical Standards for Property Surveys, recently adopted by the American Congress on Surveying and Mapping, call for an accuracy of 1/10,000.

Manual No. 10, however, labels the equipment generally used by the property surveying profession as third order, with a corresponding accuracy of 1/5,000 in position closure.

These many contradictory facts leave a final determination of a proper and practical working accuracy for property surveys considerably in doubt.

A 15-Year Study of Accuracies

In order to throw light on this matter, the writer made an investigation, in 1941, of actual accuracies obtained in his office in 15 years of work in property surveying. The results were published in Transactions of the American Society of Civil Engineers in 1943, under the title "Relative Angular, Linear and Traverse Accuracies in City Surveys."

A large number of angles, which had been reobserved after an appreciable

time lapse within the 15-year period, were compared, and their probable errors computed. The frequencies of the probable errors were determined as percentages, and the results were plotted as an accuracy-frequency curve (Fig. 1, Curve 2). The mean probable error of all angles so studied was found to be 7.0 seconds.

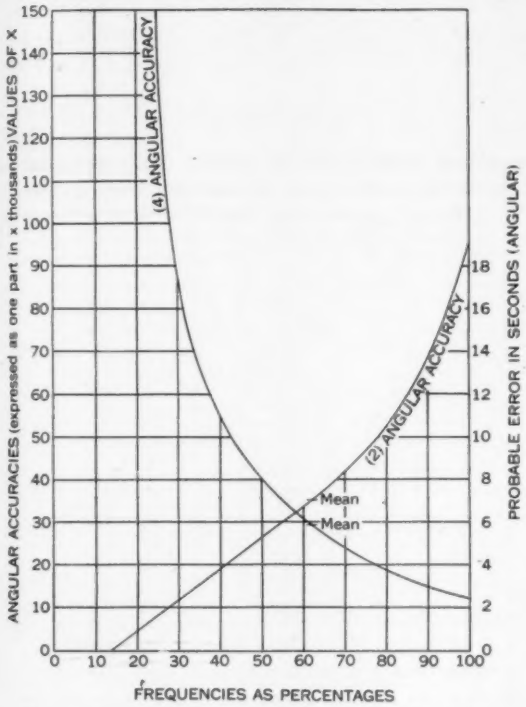
ANGULAR ACCURACIES (expressed as one part in x thousands) VALUES OF X
PROBABLE ERROR IN SECONDS (ANGULAR)
(4) ANGULAR ACCURACY
(2) ANGULAR ACCURACY
Mean
Mean
FREQUENCIES AS PERCENTAGES
0 10 20 30 40 50 60 70 80 90 100
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
18 16 14 12 10 8 6 4 2 0

FIGURE 1.—Angular Accuracy-Frequency Correction.

ANGULAR, LINEAR AND TRAVERSE ACCURACIES

In order to compare angular accuracies with linear and traverse accuracies, a common unit for accuracy expression was established, namely, the ratio of one part in x thousands. Angular accuracies were converted into that unit by using the linear effect of the angular error, expressed as one part in x thousands (expressed by the tangent of the probable error angle). Expressed in the standard unit, then, Curve 2 takes the form of Curve 4 in figure 1. Interpreting Curve 4, 50 percent of the angular observations have an accuracy of 1/40,000. All angular observations have an accuracy of better than 1/12,000. The mean angular accuracy of all observations is 1/29,500.

Linear accuracies over the 15-year period were similarly analyzed. It was found that a great variation of accuracy occurred between lines remeasured the same day, and lines remeasured after an appreciable time lapse.

Frequency-accuracy curves were compiled for lines remeasured the same day, and also for lines remeasured after an appreciable time interval up to 15 years. These curves are shown in figure 2 as Curves 5 and 6. The mean linear accuracy for lines remeasured the same day (under the same circumstances) was found to be 1/31,300; whereas the mean of lines remeasured after an appreciable time lapse was found to be 1/22,800. Traverse closures were similarly plotted as an accuracy-frequency curve in the common unit of one part in x thousands, with a mean closure found to be 1/22,600 (Fig. 3, Curve 8).

In order to study the relationship between the linear and angular accuracies, and the resulting traverse closures, the curve of angular accuracy and the curve of linear accuracy for lines reobserved on the same day were plotted together with the traverse curve. (*See* fig. 3.) Curve 9 in figure 3 is a calculated curve,

obtained by combining the angular and linear probable errors at the various frequencies, in accordance with the least squares rule that the probable results of the combination of two or more accidental errors is equal to the square root of the summation of the squares of the accidental errors. The marked similarity between theoretical Curve 9 and the actual traverse Curve 8 in the normal range of accuracy, would seem to indicate an agreement between theory and actual results.

It is to be noted that all of the traverses studied in the above paper were loop closures, i.e., closures upon the point of beginning. Loop closures, however, do not express anything more than consistency of work. Only position closure (i.e., a traverse between two points fixed by a precise geodetic control) is a measure of true accuracy. In the final discussion of the previous paper, the writer attempted to predict the position closure that the instrumentation and procedure used, would produce. (At that time no geodetic control existed in the locality.) For that purpose, the writer combined angular Curve 4 and linear Curve 6 (the accuracy of lines measured after an appreciable time interval) into a theoretical traverse curve as above. This combination of accuracies approaches the condition of position closure, since the latter linear accuracy takes into consideration such errors as errors of tape length, climatic conditions, etc. By this theory, a mean position closure of 1/18,000 was calculated for the instrumentation and procedure used.

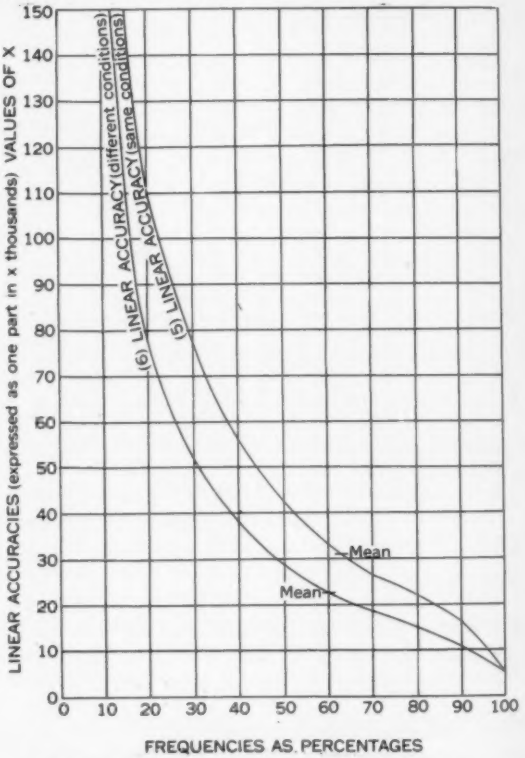

FIGURE 2.—Linear Accuracy-Frequency Curves.

Since that time a geodetic control has been developed in the locality, and the writer has run 25 miles of traverse between transfer points of the geodetic control. All of this work was performed with the standard equipment and procedure of the profession. The mean position closure obtained to date is 1/17,000.

From these results it seems safe to say that second-order accuracy is obtainable with the equipment and procedure used, and that, lacking a geodetic control, loop closures of an accuracy of about 1/25,000 can be maintained. Both values

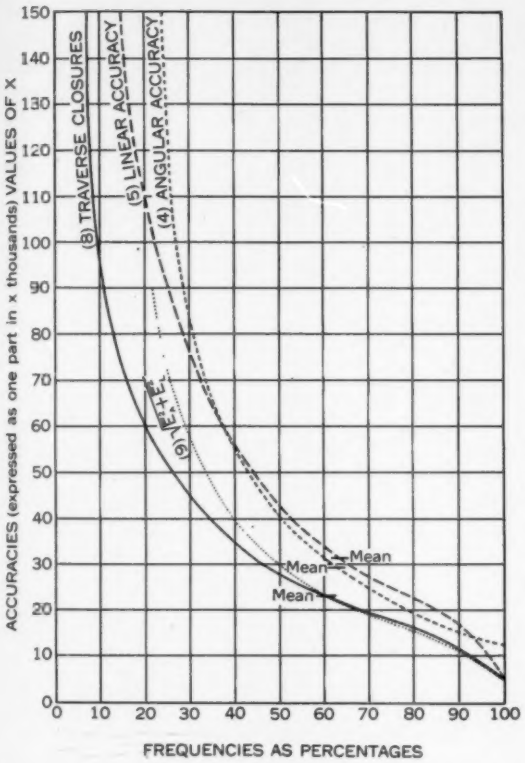

FIGURE 3.—Relationship between Linear and Angular Accuracies and Traverse Closures.

are higher than any generally claimed for the instrumentation, and higher than is generally held necessary for first-rate property-line surveys.

Having established that a high accuracy is inherent in the instrumentation used by our profession, we are yet faced with the problem of a "practical" accuracy for the practicing property surveyor.

PRACTICAL CONSIDERATION FOR THE PROPERTY SURVEYOR

Engineering has been called "the practical applications of science." High accuracy may be good science and yet be poor engineering. To be "practical" an accuracy, in addition to meeting the minimum requirements of the job, should also satisfy the following conditions:

1. It should have material value, as such, to the client and the surveyor (beyond that of personal satisfaction).
2. It should be obtainable with the personnel and equipment generally used for such work by the profession.
3. It should be obtained at a speed that will not make for excessive cost.

1. *Value to Client and Surveyor*

To the transient surveyor, any accuracy above the minimum requirements of the job is unnecessary. Continued practice in the same locality, however, introduces additional factors in the matter of a desirable and practical accuracy. Clients' requirements change, use of land changes, the survey is needed and used for purposes not originally contemplated. The immediate situation is only one of many factors determining proper accuracy for the practicing surveyor, who intends to continue to practice in the locality. New construction and new uses add importance and value to land. Valueless remnants of land may become extremely important after a time. Examples of this sort are endless in the experience of every surveyor, and prove to the practicing surveyor the danger of gauging surveying accuracy by the immediately apparent land value. Good

professional practice should demand an accuracy satisfactory at least to the mean high value of the general locality, since time or use may change the values from low to high in relatively short periods. The practicing surveyor finds the need of a factor of safety in his accuracy to absorb changes in land values, land use, and other factors that change with time.

Every surveyor of a few years' practice finds himself back on a job, or adjoining a job he once did. A missing or moved point must be replaced. That additional work involves a reduction of accuracy from the accuracy originally contained in the job. Assuming that some minimum accuracy is to be held, it is clear that again the original work must contain a cushion of accuracy to absorb the reduction brought about by additional work, in order that, in the end, the work remain within acceptable limits.

Frequently the property surveyor is called in to cut off a part of a piece of land he previously surveyed. Such a cutoff line is the severest test of accuracy, since it involves the adjustment as well as the precision of the original observation. A cushion of accuracy in the original survey is necessary in order to leave the surveyor with a minimum accuracy that is acceptable, after the reduction created by the new work. Lacking such excess of accuracy, the surveyor is faced with either a result that is below standard, or the embarrassing situation of altering previous measurements and resulting difficult explanations to a client.

One of the most difficult problems in property-line surveys is the frequent one of the job that grows big from a small start. Expansion of a survey or a control plays havoc with accuracy; nevertheless owners add to their holdings and, unless a considerable factor of safety of accuracy exists in the early work, a few additions of areas are certain to reduce the accuracy of the whole to unsatisfactory levels.

It has been argued that a surveyor cannot be expected to anticipate changes of value, use, or condition of the land he surveys; that should those factors change so much as to render his early survey insufficient in accuracy, the situation would be beyond his control and would not be his responsibility. Though we may so argue, the client in the case however, is not apt to be so broadminded. To the client, should such a situation develop, the surveyor has made a mistake, irrespective of any unforeseen change, or even any price limitation or conditions the client himself may have imposed upon the surveyor at the time of the original survey. The surveyor may help his ego by his logical argument, but he has lost a client and has hurt his own reputation. His only practical defense is more accuracy than is seemingly necessary for the immediate job.

Text books generally preach that it is proper practice to alter accuracy to fit the value and demand of a job. Practically, the client recognizes no such distinction; a survey is either "wrong" or "right" to the client. The bitterest property-line disputes in our experience involved insignificant areas, and often lands of low value. In case of a property-line dispute, the owner invariably expects a rigid property-line solution without regard to land value or other theoretical consideration. Unfortunately, the rule of engineering economy, of scaling the work to the particular job, is apt to invite trouble and reflection on the professional reputation of the surveyor who continues in business in the same locality. Good practice demands a factor of safety of accuracy in all work as a practical expedient.

2. *Limitations of Available Personnel*

The second test for a "practical" accuracy requires that it be obtainable with the type of help usually employed for the work. We must assume that the party leader is a competent professional surveyor. Chainmen or transitmen, however, are often men with little or no technical schooling, and rodmen often have no training at all. It is our experience that, assuming the helpers can learn at all, they can be trained to be sufficiently competent at their various duties within a week or two. During the years 1940–44, the writer like other employers, suffered considerable employment difficulty. The average stay of rodmen and transitmen was 9 weeks. Of the rodmen hired during this period, only four had any previous experience in survey work. Nevertheless, in that period, our mean traverse loop closure rose from 1/22,600 to 1/27,000—due, in part, to better than average terrain and the use of spring balance in taping.

The work of the rodman requires no special talents beyond a willingness to take orders. The rodman learns his job by repetition, and will learn more quickly if he is given one method and one degree of care with which to do each step of his work. He can be taught carefulness by constant insistence, as well as he can be taught to drive a stake. If he is taught always to do each job in a fixed way, and always with care, he soon falls into that routine. To vary the procedure, even if only to let down in carefulness, breaks the repetition. He must learn the new procedure as a new job, even if it differs from the previous one only in being less careful. Unfortunately, it is more difficult to relearn the more careful technique after learning the lesser.

It is the opinion of this writer that it is easier to maintain the high accuracies indicated here, with consistency, than to maintain with equal consistency a considerably lower level of accuracy, for the reason that a lessening of care leads to carelessness and the many blunders that can so easily be made in a survey, unless consistent vigilance is maintained. There is a marked value in the discipline that constant care produces, in the elimination of large mistakes, such as mistakes of 100 feet in measuring, holding on the wrong point, etc. In 20 years of practice, only three traverses had to be reobserved by this office because of such observational mistakes, and only five traverses came in under 1/10,000 loop closure, including all types of work.

3. *Consideration of Speed in Relation to Cost*

The third test of a "practical" accuracy requires that it should be obtained at a speed that will not lead to excessive costs. It is not to be denied that there is a difference in the time a survey requires by different observational methods. A certain type of so-called "survey" widely used in mortgaging practice is performed at the rate of 10 to 20 jobs per day per party. The average simple property survey, however, rarely takes less than one-half day in the field. The difference between the two is only in a very small measure due to difference in observation procedures. Essentially the difference in time is due to the difference in the amount of investigation in each job. In neither case is the time spent in observation of angles and distances more than a small part of the time spent on the job; and the difference in observational procedure is only a part of that.

Careful observational procedure does add to field time. However, once a transit is set over a point, it ordinarily adds little to the total time of the observation of that angle whether an angle is turned two or six times. In taping, it

adds somewhat to the working time to plumb carefully and check the point set before moving on, but when viewed from the standpoint that the drive to and from the job alone might be an hour or two, that an error due to carelessness, or a sub-standard closure, might require an extra trip for reobservation, involving traveling time considerably in excess of the actual observing time, it would seem good economy to add slightly to the taping time, as a precaution against the necessity for re-runs.

Property-line surveys vary so greatly as to work involved that it is difficult to estimate the percentage of the time of a survey that is spent in observations of angle and distance alone. However, with two- or three-man parties, the writer has run the 25 miles of purely traverse survey indicated above, at a rate of 4300 feet per day, including all time charged to the job, and including travel to and from the job, including the locating of monuments, setting of intermediate traverse points, and observation of angles and distances. In ordinary property-line surveys, a mean of 1500 feet per day of outline represents the average job condition. Assuming 4300 feet a day as the rate of observation procedure alone, and 1500 feet per day the average rate of outline survey, then the average observing time is about 35 percent of the time of the job in the field. Calculations of costs indicate that the cost of the field work in property-line surveys is ordinarily approximately 60 percent of the total cost of the job. Then the observing of angles and distances represents approximately 20 percent of the cost of a property-line survey, and a procedure that increases the observation time by as much as 50 percent, increases the total cost of the job by only 10 percent. Counterbalancing such an increase in cost are the many advantages already cited for the increased accuracy thereby obtained.

Summary

In summary we arrive at these conclusions:

1. A high order of accuracy is inherent in the ordinary equipment used in private survey practice—an accuracy that is considerably higher than that generally credited to the equipment, and an accuracy higher than generally suggested as necessary for property-line surveys.
2. Accuracy, higher than may be required for a specific job, has value to the client, and is necessary to the surveyor who remains in business in the same community, in that it
   (a) permits reproduction of lost points within satisfactory limits;
   (b) permits expansion of the job with satisfactory accuracy;
   (c) permits additional and new work upon the same premises without reducing accuracy below an acceptable minimum;
   (d) allows for increase of land values over the years;
   (e) more nearly meets the layman's inflexible definition of accuracy.
3. High accuracy can readily be achieved and maintained even with relatively inefficient helpers, after a short period of training.
4. High accuracy can be accomplished at a speed that in itself will not materially increase the cost of the job.

With these facts established, it follows that the high accuracies inherent in the equipment are "practical" and should be maintained by practicing surveyors of property lines as good professional practice.

Since local topography and conditions affect accuracies, it is not this writer's idea to claim that the specific accuracies found in this study are the practical

accuracies for property-line surveys in all localities. The attempt is rather to prove that the inherent high accuracy of the instrumentation is the practical accuracy of work, and that accuracy is well worth the effort necessary to achieve it.

* * *

The "Terminus" Iron Boundary Post

THE QUESTION of a permanent post or monument to define land boundaries is not new; the need for such a post has long been realized by governments, landowners, and the surveying profession. In the early surveys of Canadian lands, wooden posts, usually referenced by bearing trees, were used almost exclusively. This was due in part to the urgent need for subdivisions for land holdings and in part to a lack of foresight. As the years passed, it soon became evident that many of the posts or monuments had disappeared, and the re-establishment of lost corners became difficult and costly. From time to time efforts were made by governments and surveyor's organizations to design and bring into use a post or monument more likely to withstand the ravages of time and misadventure. In the early subdivisions of the great western plains, wooden posts were used almost entirely. Later, iron posts and monuments of earthmound and pits or, where available, stone cairns, were introduced. Improvements were made from time to time in the design and planting of these posts and today the standard D.L.S. post is fairly permanent. But even in a country so relatively young as Canada, hundreds of posts and monuments have disappeared and the re-establishment of lost corners is an ever-increasing problem; it is often necessary for a surveyor to retrace several miles of line in order to establish the true position of a single lost corner. A more permanent post or monument would go a long way in solving this problem.

In designing such a post, such factors as weight, durability, ease in planting, difficulty of removal, and cost, must be kept in mind. J. P. Dutil, a Quebec land surveyor, has recently designed a post with a view to meeting these requirements.

Essentially the post is a square iron shaft, provided with an aluminum head upon which may be placed the necessary inscriptions. (*See* fig. 1.) It is also provided with two anchor arms which are disposed vertically along the shaft. These arms are held in position by a metal riveted pin through the shaft; they are made with flanges which rest against the shaft preventing the arm slipping past and are curved outward at the top away from the shaft. The aluminum head is square and secured to the shaft by a strong rivet passing through the shaft. The lower end of the shaft is pointed for easy driving.

In planting this post the anchor arms are turned up against the sides of the shaft and the post driven into the ground as far as desired with a sledge; then an upward pull is exerted on the lower edge of the head and the post pulled up a little. Because the upper ends of the arms diverge, they tend to swing downward

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as the shaft is pulled up and come to rest at right angles to the shaft, with the inner ends of the flanges abutting the shaft. When in this position, it is exceedingly difficult to pull the post out of the ground.

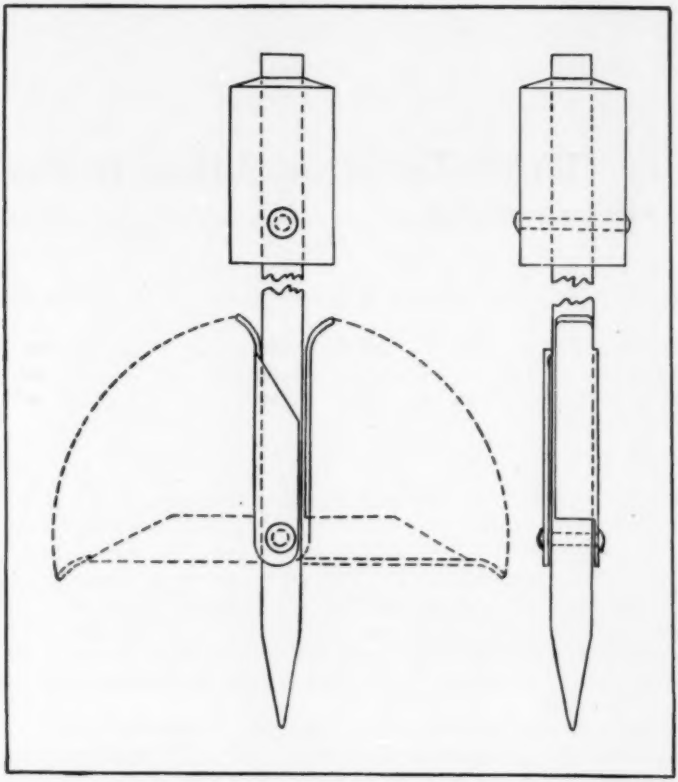

FIGURE 1.—The "Terminus" Iron Boundary Post.

The post is available in six sizes, as follows, to meet the needs of different classes of surveys, and to provide a choice for prospective clients.

The post is available in six sizes as follows:
(1) Shaft $\frac{1}{2}$″ square, 24″ long with aluminum head $1\frac{1}{4}$″ square and $3\frac{1}{2}$″ long.
(2) Similar to (1) but 30″ long.
(3) Shaft $\frac{5}{8}$″ square, 24″ long, aluminum head $1\frac{3}{8}$″ square and $3\frac{1}{2}$″ long.
(4) Similar to (2) but 30″ long.
(5) Shaft $\frac{3}{4}$″ square, 24″ long, aluminum head $1\frac{3}{4}$″ square and 4″ long.
(6) Similar to (5) but 30″ long.

At special request, posts with shaft $\frac{7}{8}$″ square, 32″ long have been supplied for use in Prince Edward Island and Nova Scotia.

Accurate Trigonometric Leveling Uses Ordinary Transit

By O. B. MISZ*

QUICK AND ACCURATE long-range leveling can be accomplished by a method of observing angles on the vertical arc of an ordinary transit to the same degree of precision as horizontal angles are determined in precise triangulation work. Based on the principle of angle measurement by repetition, the method uses the transit's leveling screws as a second vertical motion. No special skill on the part of the instrumentman is necessary.

In determining the vertical angle between two stations, the plate is clamped so that the telescope is as nearly as possible in line with one pair of leveling screws. The leveling screws are then loosened and the instrument turned to point at the target with the plate approximately level transversely.

With the instrument thus oriented, the front and rear leveling screws are manipulated to bring the plate into an inclined plane as steep as the leveling screw threads will permit. If the target is above the horizontal plane of the instrument, the front of the plate is raised; if below, it is lowered. The telescope is then leveled by means of the vertical motion, and the vertical vernier reading is recorded as "Direct—0" (see "Sample Field Record" below).

SAMPLE FIELD RECORD OF VERTICAL ANGLE OBSERVATION

Inst. at—*Butte* H.I.—*4.75*		Sighting at—*Pinnacle* *White flag 10.32 high*	
First Set		Second Set	
Reading	*Angle*	*Reading*	*Angle*
D.—0	−6° 15′	D.—0	−5° 58′
*D.—1	−5° 01′	*D.—1	−4° 45′
D.—10	+6° 06′	D.—10	+6° 21′
R.—10	−6° 14′	R.—10	−5° 59′

* This reading is taken to prevent error in counting number of turns and for a rough check on resultant vertical angle.

Measurement of the angle then proceeds as follows:

Bring the center cross hair exactly on the target. Record the vertical vernier reading as "Direct—1." This will finish one "direct turn," and serves to prevent error in counting the number of turns and as a rough check on resultant angles.

By manipulating the front and rear leveling screws to bring the telescope to a level indication, and by sighting the target with use of vertical motion screws, as many "direct turns" may be made as the lengths of plate-leveling screw threads will permit. At the end of this series of direct turns the telescope will be pointed to the target. Read the vertical vernier and record the angle as "Direct 4, 6, 8, 10," as the case may be (ordinarily vertical angles will be such that 10 turns can be made).

Make as many reverse turns as there are direct turns by bringing the telescope to level indications with use of vertical motion screws instead of plate leveling

Reprinted through the courtesy of *Engineering News-Record,* March 7, 1946.

* Field Engineer, Bureau of Reclamation, Phoenix, Arizona.

screws, and to sightings on the target with use of plate leveling screws instead of vertical motion screws. The telescope will be clamped at level indication at the end of this series of reverse turns. Record the vertical vernier reading as "Reverse," giving it the proper number.

The first set of readings is now complete. As in measuring precise horizontal angles, however, another set is taken. This completes the field work.

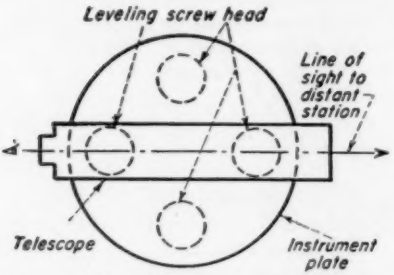

FIGURE 1.—Precise measurement of vertical angles with ordinary transit requires that line of sight be fairly close to alignment with one pair of leveling screws.

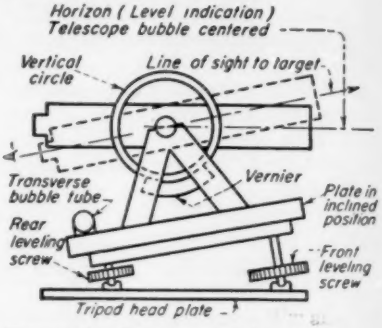

FIGURE 2.—Greater precision in observing vertical angles is gained by using plate-leveling screws on second vertical motion for measurement by repetition.

REDUCTION OF NOTES IS SIMPLE

Reduction of the vertical angle observation is simple. For each set, the D—0 and the last of the reverse readings are averaged and this value is subtracted algebraically from the last of the direct readings. In each case the result is the average cumulative angle for the number of turns made in that set.

The final answer is found by averaging this value from the first and second sets and dividing by the number of turns in each set.

In all but exceptional cases the stations sighted will later be occupied and reciprocal observations should be made so that true differences in elevations may be determined. This can be done by averaging each two apparent differences in elevation without dependence on instrument error and curvature plus refraction.

After two or more pairs of stations have been observed by the reciprocal method, an exact determination of the instrument error and the "earth curvature plus refraction" should be calculated. For more accurate determination of these factors, one pair of stations should be not far apart (preferably about two miles) and the other pair a distance of about three or four miles apart. Comparison of apparent differences in elevation with true differences in elevation, determined by the reciprocal observations, will show how the instrument error and earth-curvature-plus-refraction factors can be determined.

SMALL ANGLE REDUCES DISTANCE ERROR

Such determinations should be made using different groups of stations until the average will be within the accuracy desired. After this has been done accurate differences in elevation may be determined for those stations between which reciprocal observations were impracticable.

Each instrument used in an extensive survey should have its correction factors recorded, and should be continuously checked to guard against any change in instrument error. It is not intended to enter into the mathematics of how these factors may be determined, except to state that it may be assumed that instrument error increases as the distance, and earth curvature plus refraction increases as the square of the distance between stations.

In cases where the angular difference in elevation between two stations is greater than desirable, the distance may be redetermined to an appropriate degree of accuracy. It is preferable, however, for the instrumentman to offset, whenever practicable to do so, to an elevation that would reduce the size of vertical angle and minimize the effect of distance error.

As angles become very great the number of turns which can be used within the range of the plate leveling screws is diminished rapidly. An angle of 10 degrees would probably require constant adjustment of one leg of the tripod to make four turns direct and four reverse.

As the method described was devised for long-range leveling by vertical angles, possibilities of turning large vertical angles need not be explored. Although it is apparent that its greatest usefulness would likely be in extensive triangulation networks, the method has been used on long-range determinations for pier bridge seats and has shown benefits in most surveys, rough or precise, because of its accuracy and savings in time and labor.

* * *

Microseism Theory Tested

THE FLORIDA-LOUISIANA HURRICANE, because it was such a big one, gave Navy scientists an excellent chance to test out the relatively new microseismic method for tracking these tropical storms, from six observatories now in operation at Miami and Richmond, Fla.; Corpus Christi, Texas; San Juan, P. R.; Guantanamo, Cuba; and Swan Island in the Caribbean.

This method depends on the apparent association between big storms and tiny shiverings in the earth's crust that register themselves on seismographs, or earthquake-recording instruments. These tiny tremors, which have no known connection with the heavy shocks of true earthquakes, are known as microseisms.

A connection between microseisms and storms was vaguely noticed long ago; it was suggested that pounding of storm-surf on the shore might cause them.

The theory was brought to a more definite focus a few years back by the Rev. James B. Macelwane, S.J., of St. Louis University, well-known researcher on earthquakes. His suggestion was that the tremors started, not on shore, but on the ocean bottom under the centers of tropical storms or hurricanes. Later he put forth the supplementary hypothesis that the mechanism that started the microseisms was a piling up of the ocean water, pushed toward the "eye" of the storm by the wide inwhirling wheel of the hurricane winds. This still remains to be proved or disproved.

The Aerological Section of the U. S. Navy has taken over the development of research along these lines, with the idea of eventually being able to track hurricanes and typhoons along their often erratic courses.—*Science News Letter,* October 4, 1947.

The State Coordinate Systems

By W. O. BYRD

CHIEF COMPUTER, MAPS AND SURVEYS DIVISION, TENNESSEE VALLEY AUTHORITY

EDITOR'S NOTE.—Because of the importance of the subject, it is planned to publish in future issues of the Journal articles dealing with various phases of the State Coordinate Systems with a view to developing a better understanding and a wider use of the method by surveyors and engineers. Discussions and comments on any aspects of the Systems are welcomed.

IT HAS BEEN our experience that a considerable number of surveyors and engineers hesitate to use the State Coordinate Systems because they feel that the requirements are complex and that they lack sufficient spare time to acquire a working knowledge. We hope, therefore, that we shall be able this morning to clarify some fundamental notions regarding Statewide Plane-Rectangular Coordinates and the closely related subject of map projections.

One could devote an entire lifetime to the study of coordinate systems and map projections and still not completely master these limitless subjects. Similar statements could be made with respect to any number of subjects, one, for example, being radio. Now a lack of complete understanding prevents no one from using the radio—it is simple to operate and to enjoy. So it should be with State Coordinates—their application is quite simple, and the advantages resulting from their use are almost countless. Or, to present an illustration from surveying, consider leveling. No one hesitates to determine elevations on the adopted mean sea level datum. The surveyor or engineer obtains from some governmental agency the elevations of bench marks needed to initiate and close his leveling, and while he may be unfamiliar with the determination of these elevations, with orthometric corrections, and with precise leveling equipment, he nevertheless makes use of the values without question. In so doing his survey is on the adopted elevation datum, and he may easily make use of information from other sources which are also on this datum. State Plane Coordinates are just as easy to use as the elevations of the given bench marks when the needed initial and closing data, which include azimuths as well as coordinates, are available.

BENEFITS TO BE DERIVED FROM USE

Let us consider briefly some of the benefits resulting from the use of the State Coordinate Systems. Each System furnishes a medium for surveying and mapping over an extensive region which permits the utilization of the survey data provided by the national triangulation net and other geodetic surveys, and simultaneously allows the retention of all the advantages of plane surveying methods. And speaking of the use of geodetic control, the following quotation is especially interesting. In October 1938, Mr. Oliver T. Ray, State Director, Division of Highway Planning, State Highway Board of Georgia, wrote in the Foreword of the volume Geodetic Survey of Georgia, "we estimate, nominally, that the use of the Georgia geodetic control has saved us an actual expenditure

This is a modification of a paper presented by the author at the Surveyors' Short Course held at the University of Tennessee, April 12–13, 1946.

in field costs alone of $30,000 to $40,000 in the one year we have been using it. It will be invaluable in the future—for without it we would be lost."

Use of the State Systems reduces field and office costs. Complicated and tedious geodetic computations are not required. Computations involve no more than the usual plane trigonometry and plane analytic geometry of the well-known plane-surveying procedures. Plotting is facilitated. Advantages are obtained in maintaining survey records.

Local surveys and maps which are accurately positioned on a State System are referenced to the adopted geodetic datum and are assured of joining similar surveys and maps of adjacent areas without overlap or gap. An easy means is afforded for the interchange and use of survey and map information from any source which is also based upon the State Coordinate Systems. Moreover, this mutual exchange of information tends to promote greater co-operation among surveyors with the resultant general betterment of the profession.

A lost or destroyed land survey corner can be easily and accurately recovered or replaced if its State Coordinates are accurately known because of the vast number of geodetic control markers which act as witnesses.

State Coordinates are also useful for location purposes other than surveying. For example, some police and fire-fighting organizations now direct their field forces by radio with the aid of maps which show State Coordinate grids.

Progressive private and public engineers of the country are becoming increasingly convinced of the utility of the Systems and take every occasion to encourage wider usage. The Board of Surveys and Maps of the Federal Government, in a report adopted September 8, 1936, recommended to its member organizations that, "wherever practicable, they adopt the systems of plane coordinates devised for the various states by the Coast and Geodetic Survey, and use these State Systems of plane coordinates as bases for such of their surveys and maps as will not, because of their nature or extent, require the use of some other system of coordinates or method of recording." The Maps and Surveys Division of the Tennessee Valley Authority uses the State Coordinate Systems in all its surveying and mapping activities for which their use is appropriate.

Over 40 percent of the states have adopted legislation establishing the legal status of the Systems and permitting the use of State Coordinates in cadastral descriptions. (*See* fig. 1.)

Development of the Systems

Beginning in 1933, the United States Coast and Geodetic Survey established within a short time a system of plane-rectangular coordinates for each of the States of the Union. The foot is the unit of measure for the coordinates, and the coordinates have only positive values. In designing the Systems, the Survey strove to obtain simplicity and uniformity without introducing any distortion likely to trouble the surveyor. For some states, a single origin and meridian of reference are adequate. For example, Tennessee has only one such zone, which is known as the Tennessee Coordinate System. (*See* fig. 2.) It is necessary in other states, because of their extent, to have two or more zones, each zone having its own origin and reference meridian. For example, Alabama has two zones, known as the Alabama Coordinate System, East Zone and the Alabama Coordinate System, West Zone. (*See* fig. 3.) Divisions between zones in the same state follow county lines. A survey which crosses a political boundary

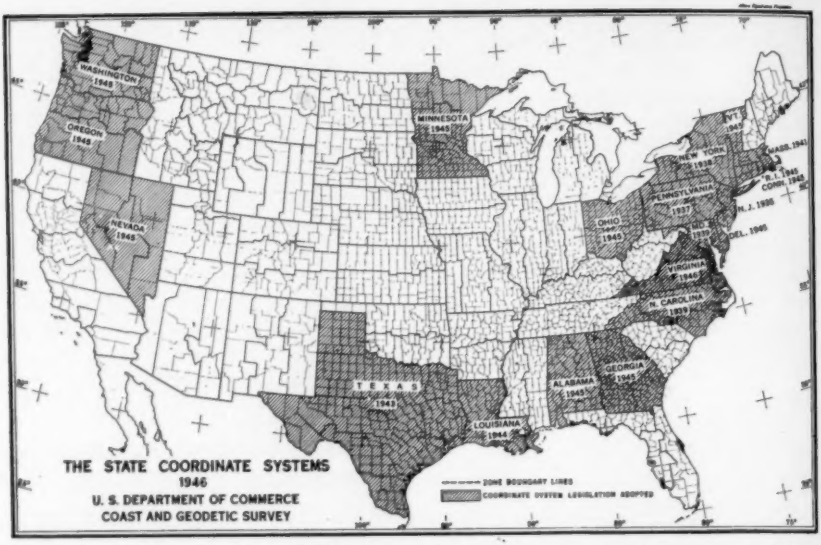

FIGURE 1.—States where Coordinate Systems have been legalized for land descriptions.

separating two zones may usually be computed on either or both zones, since considerable overlap of essential data is provided.

THE PROBLEM OF CARTOGRAPHY

Before examining the characteristics of the State Coordinate Systems, let us glance at the fundamental problem which confronts cartographers. This problem is the representation of the adopted spheroidal surface of the earth on a plane. We are all familiar with the conventional parallels of latitude and meridians of longitude, and know that the location of any point on the surface of the earth may be stated without ambiguity by means of its latitude and longitude values. The problem therefore becomes one of representing in some fashion, the parallels and meridians on a plane surface. In fact, a map projection may be defined as the orderly arrangement in a plane of lines which represent parallels and meridians on the surface of the earth. There are innumerable ways of doing this, but all result in some distortion. The amount and nature of the distortion can be controlled by limiting the area mapped and choosing the most advantageous type of projection. The purposes for which the projection is to be used, together with the ease of construction, should determine the particular type selected.

The State Coordinate Systems are based on a class of projections known as conformal or orthomorphic. A distinct characteristic of this class is that angles between corresponding lines or curves on the projections and on the earth are equal, so that the shapes of infinitesimal figures are preserved. The important fact that angles on the earth are duplicated on these projections peculiarly fit them for survey work. Actually, slight angular differences are ordinarily present because a straight survey course on the earth is usually slightly curved on the projection instead of straight as considered, but these differences are negligible on the State Coordinate Systems for most surveying purposes.

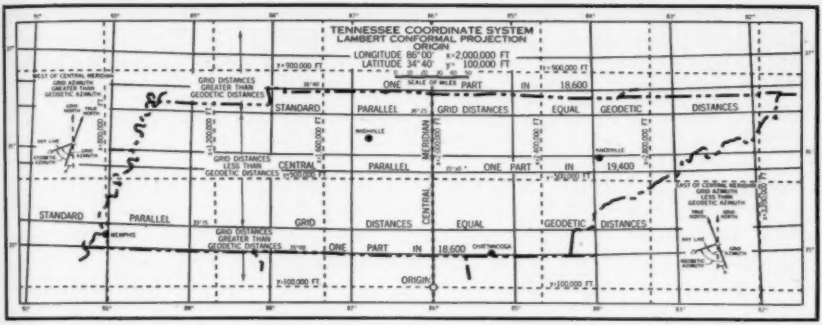

FIGURE 2.—In Tennessee a single origin of coordinates is sufficient to meet the accuracy requirements of the surveyor.

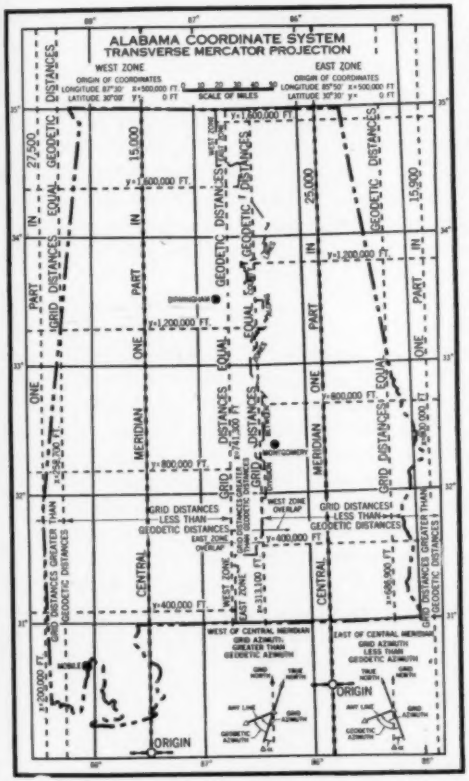

FIGURE 3.—Alabama requires two origins and two meridians of reference.

Plane-rectangular coordinate grids superimposed on conformal projections are ideally suited for the computation of traverse surveys, which comprise the bulk of local surveys. They are also well suited for fourth-order triangulation, and are applicable to triangulation of higher order if the triangles are small. They could be used for triangulation of third or higher order covering extensive regions, but are not generally used for this purpose because angular corrections would then be necessary.

Two kinds of conformal projections were used as bases for establishing the State Systems. For zones of larger east-west dimension, as the one which is the Tennessee System, the Lambert conformal projection was selected (fig. 2); while for zones of larger north-south dimension, as the two which are the Alabama System, the transverse Mercator projection was chosen (fig. 3). State Systems based on these projections are popularly designated Lambert grid and transverse Mercator grid, respectively.

Distances on a State Coordi-

nate System, that is, on the projection adopted, are known as grid distances, and distances on the adopted sea-level surface of the earth are known as geodetic distances (taped distances corrected for elevation of stations above sea level). Grid-scale factors, which are ratios of grid distances to corresponding geodetic distances have been tabulated with appropriate arguments for every State System.

Computing Traverses on State Coordinate Systems

To compute an ordinary traverse on a State Coordinate System, we use the observed field angles without modification other than the usual adjustment for closing azimuth discrepancy and never have to change the geodetic distances by more than a small amount to obtain corresponding distances on the coordinate system, or grid. Now let us examine the magnitude of the upper limit of this difference between geodetic and grid distances. If the width of the zone does not exceed 158 miles, and the widths of only a few zones exceed this value, the grid can be designed so that the difference will not exceed about 1 part in 10,000. This is very small and may be neglected altogether for most surveys, certainly for those of less than third-order accuracy. To comprehend just how small this upper limit of the difference in distance is, we have only to remember that 1 part in 10,000 is equivalent to 0.01 foot in 100 feet; or that a steel surveying tape changes its length by that proportion when its tension is changed 15 pounds or its temperature is changed 15 degrees; or that a distance measured at an elevation of 2100 feet above sea level is about 1 part in 10,000 longer than the corresponding sea level distance; or finally that linear differences of 1 part in 10,000 make a difference of 0.02 acre in 100 acres. Even when the difference between geodetic and grid distances occasionally exceeds 1 part in 10,000, a high degree of accuracy can be maintained because its value is definitely known and can be considered.

The deviation of the grid-scale factor from unity is therefore small; but what is more important, the rate of change of this factor from one point of the projection to another—and this change in the factor is really what produces distortion—is indeed extremely small. The rate of change of the factor increases from zero at the central line of a zone to a maximum at its edge which seldom exceeds 1 part in 200,000 per mile. Hence it is possible to use an average grid-scale factor over a region of considerable extent for the conversion of geodetic distances to grid distances. For most surveying purposes a single factor will suffice for a small county. Furthermore, for surveys of third or higher order, measured distances are generally corrected anyhow for the following six conditions of measurement in order to obtain geodetic distances: (1) inclination of tape; (2) calibration of tape; (3) tension of tape; (4) catenary of tape if not supported throughout; (5) temperature of tape; and (6) elevation of the survey above sea level. It is apparent, therefore, that the inclusion of one more correction to measured distances, namely, the correction to change geodetic distances to grid distances, does not add appreciably to the labor of computation. Moreover, this labor is usually minimized by making tables or graphs to aid in determining the corrections applicable to a particular survey, and ordinarily several of the correction factors can be combined.

In computing traverse points on a State System, each azimuth or bearing is referred to the central meridian of the system and is known as a grid azimuth

or grid bearing. Except for a quite small correction angle which is ordinarily present but usually neglected, the difference between the grid azimuth of a line and its geodetic, or true, azimuth is known as the *theta angle* on a Lambert grid and the *delta alpha angle* on a transverse Mercator grid. (*See* figs. 2 and 3.) Theta and delta alpha depend upon the location of the initial point of the line and are independent of its azimuth and length. Each represents the angle on the grid by which the meridian at the point converges toward the central meridian, and hence is zero for points on the central meridian. Either may be obtained by a simple computation or by interpolation from tables.

After the grid bearings and grid distances have been computed the coordinates of the traverse points are obtained by the usual latitude and departure method.

How to Obtain State Coordinate Data

The stations established by the first- and second-order triangulation and traverse of the United States Coast and Geodetic Survey, the positions of which are rigidly adjusted on the North American datum of 1927, provide the basic horizontal control for surveying and mapping in the United States and for the location on the ground of the State Coordinate Systems. Upon request the Survey will furnish descriptions, State Coordinates, and grid azimuths for its control stations in a specific locality. The area in which control data is desired may be identified by its approximate geographic position, its location relative to a town, or an outline on a suitable map. The Survey will also furnish upon request essential projection tables for facilitating position, azimuth, and distance conversions from geodetic to grid and vice versa. Requests for survey control or projection data should be addressed to the Director, U. S. Coast and Geodetic Survey, Washington 25, D. C.

The United States Geological Survey establishes control stations in connection with its extensive surveying and mapping activities. Information concerning these stations may be obtained from the Director, U. S. Geological Survey, Washington 25, D. C.

For the region within and immediately adjacent to the Tennessee River watershed, the Maps and Surveys Division of the Tennessee Valley Authority maintains considerable survey control information for markers established or used in its many surveying and mapping operations. Requests for data should be addressed to Mr. Ned H. Sayford, Chief, Maps and Surveys Division, Tennessee Valley Authority, Chattanooga 2, Tennessee.

Should station marks or inquiry reveal the existence of other surveys in the locality, requests for information may be addressed to the federal, state, or private organizations responsible for the surveys.

In conclusion it is hoped this paper will serve as introductory material for those desiring a fuller appreciation of the State Coordinate Systems. Although the mathematical development of the Systems may be found difficult, the application of the Systems to everyday surveying and mapping is fairly simple.

An excellent treatment of the subject is contained in U. S. Coast and Geodetic Survey Special Publication No. 235, The State Coordinate Systems (A Manual for Surveyors), and can be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., for 25 cents.

Surveying and Mapping Work in China

By CHIH-CHO WANG

SURVEYING and mapping work in China can be divided into three main classes; engineering, cadastral, and military. Engineering surveying is carried out chiefly by the hydrographic institutions, such as the different river conservancy commissions of the principal Chinese rivers. Surveys under the direction of these institutions are usually limited to the narrow strips of land that parallel the courses of the rivers. Topographic surveys in these areas are usually controlled by traverse lines rather than triangulation. The hydrographic surveyors in China have, however, helped to a very great extent in establishing some long lines of precise leveling.

Railway survey work, which is also included in engineering surveying, was directed by various railway administrators until 1943. Since that time the Central Bureau of Railway Surveying, under the Ministry of Communications, has maintained a co-ordination control over all preliminary railway surveying work. Railway surveying consists principally of location surveys, where traverse lines are run along the proposed directions and topography taken 100 meters on each side of the traverse.

In the early years of the Chinese Republic the administration of cadastral and boundary location surveys was entrusted to very prominent persons. However, this work was suspended as a result of numerous mishaps and extended delays. Late in the year 1928 the provincial governments undertook the task of making cadastral surveys, each province proceeding separately. Once again a department undertook to secure some unity in the work, and in 1942 the Ministry of Interior organized a Central Bureau of Cadastral Administration to co-ordinate all the related provincial operations.

The methods used in the cadastral survey have differed greatly. Attempts have been made to secure good controls by starting with the higher-order triangulation, but, because of the difficulty in the co-ordination of the time phase, lower-order triangulation and, eventually, independent traverses had to be used. The location of the property boundaries is generally done with the sighting-vane plane-table by polar distance methods. Until very recently, however, cadastral surveys have been limited to the congested urban areas and their vicinities. Here again, each survey was made separately.

Military Mapping

Of all the various phases of surveying operations in China, the military mapping program is the most comprehensive. The officials responsible for the planning hope to accomplish a nation-wide mapping program that will benefit the civil as well as the military interests. Military mapping was carried out by the Central Bureau of Land Survey under the former Army General Staff's Office. In 1943 the Bureau was raised to the status of a Department, the Fourth Department of the Board of Military Operations of the Chinese National Military Council. It

Major General Wang is attached to the Board of Military Operations, Chinese National Military Council, Nanking, China. Opinions expressed are the personal ones of the author.

is the surveying work carried out by this Bureau that this paper deals with primarily.

Geodetic Surveys

With the exception of a few experimental trials, the first-order triangulation was actually begun in China in 1929 in Chekiang Province and consisted of several triangulation chains well spread in that province. Larger-scale triangulation projects were started in 1931 by the Central Bureau of Land Survey, and first- and second-order chains of triangulation were observed in the provinces of Kiangsu, Anhwei, Hupeh, Hunan, and Kiangsi in the following years. During the war, the Land Survey Bureau moved westward to Changsha (Hunan Province), Kweilin (Kwangsi Province), and then to Kweiyang (Kweichow Province). Higher-order triangulations have since given way to lower-order ones to cope with the urgent need for control of the topographic surveys.

The figures of the triangulation consisted primarily of quadrilaterals with occasional triangles or central-point figures. In the first period, quadrilateral figures with an extra central point had been occasionally adopted, but the practice was afterwards abandoned because of the inconvenience in observation and computation as compared with the very slight increase in accuracy secured by the computations. The length of the chains ranged from 200 to 300 kilometers, con-

sisting usually of 6 to 15 figures. The average length of the sides was 30 kilometers for the primary triangulation and 20 kilometers for the secondary triangulation. One base line ranging from 4 to 8 kilometers in length and one astronomic point were usually observed at the ends of each triangulation chain.

Base lines were measured mostly with the 24- or 25-meter invar wires or, eventually, with the 50-meter invar tapes. The procedures in taking these measurements were different in accordance with the usage pertaining to the tape or wire. For example, in the case of wire measurements readings were made on the end scales of the wire at each wire distance, while with tape measurements the method of scratch-marking the exact 50-meter point on a piece of copper plate at the end of each tape distance was used. The accuracy thus obtained was principally governed by the errors of standardization of the wires or tapes, the provisions for which were definitely inadequate.

The horizontal angle of the first-order triangulation was observed in the early days by the measurement of angles in all combinations (Schreiber's method), i.e., in order to secure equal weights of all directions after adjustment. Of course, the number of sets observed in each station varies, depending upon the number of directions at a particular station. In the actual carrying out of the program of observation, however, the practice, in case of stations having more than five directions, has been to divide the directions into two groups, each group being measured by using all possible combinations within itself, there being only one line common to the two groups. This deviation is unsound in principle and has not been further adopted. Since the Survey Bureau adopted night observations, during which all the directions can easily be observed at the same time, the direction method of observation has been used.

The mean square error of each direction of the first-order triangulation amounts to $\pm 0''.50$. According to the specification, which is the same as that adopted by the United States Coast and Geodetic Survey, the error of closure of a triangle should be 1 second on the average and should not exceed 3 seconds.

Astronomic points observed by the Central Bureau of Land Survey were classified as first and second order. First-order astronomic observations, which were made for the control of the primary triangulation, included the latitude, the longitude, and the azimuth observations; second-order astronomic observations, which were primarily intended for the control of the map compilation work, consisted only of the longitude and the latitude.

The Heyde or Bamberg telescopic transit with impersonal micrometer was used for first-order astronomic longitude observations. Both the time comparison and the time of star transit were recorded on a chronograph. By observing every ten or more stars as one set, 20 to 30 sets were observed for each point. The probable error was computed as about $\pm 0''.01$. First-order astronomic latitude was also obtained by the same instrument with the Horrebow level attachment. In this case, 30 to 40 pairs of southern and northern stars were observed, resulting in an accuracy represented by a probable error of $\pm 0''.05$ to $\pm 0''.10$. Astronomic azimuth observations were made by observing Polaris with a precision Heyde or Wild theodolite. From the average of 60 to 100 sets of observations (every two sightings with the telescope normal and inverted from one set), a probable error of $\pm 0''.10$ to $\pm 0''.40$ was obtained.

Second order longitude and latitude observations were made by the astrolabe method, either with the Wild or the Zeiss theodolites with the 60° prismatic attachment or with the Cook 45° prismatic astrolabe.

The error adjustment of the observations of the primary triangulation was carried out separately in each chain. While base lines on both ends of each chain were used in the adjustment computations, astronomic points have, however, not been utilized in the sense of Laplace control. The mean square error of each direction thus adjusted was $\pm 0''.60$ to $\pm 0''.70$ for the first-order triangulation and more than $\pm 1''.0$ for the second order.

In the computation of geodetic positions, the Tobey method, first developed in Canada, has been and still is used as a standard by the Central Bureau of Land Survey, the spheroid adopted being the International.

In addition to the precise leveling work, chiefly done by the Central Bureau of Land Survey, the River Conservancy Commissions and the Railway and Highway Engineering Offices have also contributed tremendously in this field. Here again the drawback was that the work lacked co-ordination. Mean sea level datum has been set either in Taikou (Hopeh Province), Tsingtao (Shantung Province), Wusung (Shanghai), or Kangmingen (Chekiang Province), by different organizations, and some engineering surveys were based on arbitrary points. The Central Bureau of Land Survey has tried to connect most of the level lines with the Kangmingen datum as the standard normal point of sea level and published the results in 1936.

Research in the field of geodesy has been carried out by the China Institute of Geography, founded in 1940. The following are some of the subjects covered: The readjustment of the triangulation observations made by the Central Bureau of Land Survey between 1932 and 1937 with a view to discussing the dimensions of the earth from the results of Chinese triangulation; the propagation of errors in a quadrilateral chain; the strength of base-net figures; the use of Boltz's "Entwicklungs verfahren" in the adjustment of quadrilateral chains; and the Lambert conformal projection.

Topographic Surveys

Topographic surveying on a nation-wide scale is carried out regularly by the Fourth Department of the Board of Military Operations. Because of the urgent demands for maps in many regions, topographic surveys are very often started before the points of higher-order triangulation are supplied for control. In this case only independent third- or fourth-order triangulation was accomplished, and discrepancies in the junction areas of adjacent sheets were sometimes inevitable.

The standard series of the topographic map is on a scale of 1:50,000 with 20-meter contours. Each sheet extends 15′ in latitude and 10′ in longitude. Scales of 1:25,000 and 1:10,000 are used in very limited areas. On the other hand, maps on the scale of 1:100,000 are of a reconnaissance nature. Most of the existing maps of this latter scale were compiled rather than surveyed.

Each planetable sheet is one quarter of one topographic sheet. It is specified that 6 control points on the average should be furnished for each topographic sheet and then through graphic triangulation, 16 more control points are obtained for the detail survey. Telescopic alidades are used in graphic triangulation, while the sighting-vane alidade is used in the plotting of the topographic details.

Cartography

The Central Bureau of Land Survey has adopted the Lambert conformal conic projection with two standard parallels as standard for all the topographic maps.

There are 11 zones covering a latitude range of 3°30′ each. The spacing between the standard parallels is 2°30′, leaving 30′ beyond each standard parallel as an overlapping region between adjacent zones. The longitude 105°E is adopted as the central medidian. By such an arrangement, the maximum scale distortion in any locality is less than 1 : 4,000.

The computation is based upon the theory developed by the United States Coast and Geodetic Survey. Formulas for distance and direction corrections have been developed and supplemented. Improvement in the computation by using series expansion has been developed so that the use of 10-place logarithm tables can be avoided for the regions farther away from the central meridian.

As for map printing, one offset press is owned by the Central Bureau of Land Survey, and maps are printed mostly by the flat-bed presses. Printing plates are processed by the conventional photolithographic method. During wartime, expedient methods were used where original drawings were traced on tracing paper and lithographic plates were produced by exposing the drawings directly on them. Color printing was limited to the smaller-scale atlas maps. This process will be extended to the topographic sheets as soon as the material and equipment for that purpose are available.

Conclusion

The mapping problem in China is tremendous. There have been discussions as to the problems of a nation-wide mapping program and the co-ordination of mapping work carried out by various organizations. The former Central Bureau of Land Survey rarely had a chance to carry on a long-range program of its own. Many times such a program was planned, but its accomplishment was usually delayed because local needs always rated a higher priority. The question then arises: Is it advisable to have a complete map of uniform scale and accuracy of the whole nation? If so, which scale? The divergence of opinion lies between the map users and map producers, on the one hand, who better realize the value of maps; and the people from other fields, on the other hand, who would reluctantly approve the appropriation of funds for curved lines on paper or the co-ordinates of buried stones. The average opinion in China is, however, on the affirmative side of map making. There has been a general tendency toward adopting a uniform map scale of 1 : 50,000, with the scale of 1 : 100,000 in use in some exceptional areas.

Photogrammetry, the development of which was interrupted by the exigencies of war, will re-emerge and assume a vital part in China's mapping program. The recent developments in the use of aerial photographs for topographic surveying and the Shoran method for geodetic control will certainly expedite the program and make possible the production of good maps more economically.

(Editor's Note.—"Photogrammetry in China" by the same author appeared in the March 1946 issue of *Photogrammetric Engineering*.)

"What's the good of Mercator's North Poles and Equators,
Tropics, Zones and Meridian Lines?"
So the Bellman would cry: and the crew would reply
"They are merely conventional signs!"

—*The Hunting of the Snark*

Making Maps in the Desert

By GEORGE H. HARDING
RESEARCH PROFESSOR OF CIVIL ENGINEERING, OHIO STATE UNIVERSITY

TWENTY–FIVE miles up the Nile, above Old Cairo and on the east side of the river, rises a series of low cliffs possibly 500 feet in height. Across the Nile and a little to the north lie the pyramids of Sakkara and not far distant lie the ruins of the ancient city of Memphis. There are caves in these cliffs and they are named Tura.

From the comparative coolness of the entrance to one of the many Tura caves one could look out across a barren expanse of sand and rock, heated by the blazing African sun, toward the west to the Nile. The river is about a mile away and nearing the end of its travels, begun partly in the Belgian Congo and partly in the highlands of Abyssinia.

Water, which in upper reaches acted as does restless youth, dashing over falls and through cataracts, flowing swiftly and sluggishly by turn as if in response to unstable whims, had at last reached its more adult phase and flowed steadily on to its imminent end. The remnants of the water not removed and used by man loose themselves through the Delta tributaries into the waters of the Mediterranean.

Across the Nile begins the desert and waste land. This continues for thousands of miles and includes the vast areas of the Sahara, awe-inspiring and yet startlingly beautiful too at moments, leaving never-to-be-forgotten pictures in the minds of those who looked, and those who saw as well.

Below the cliffs on which we stand are scattered huts, sandbagged anti-aircraft and machine gun emplacements and belts of barbed wire laid out in a defensive pattern to permit the cave workers to defend themselves from both airborne and ground mechanized raiders. Occasionally Indian or Sudanese sentries stop pacing their assigned position of the protective system and gaze off into the horizon, trying to determine whether the planes seen or heard were friend or foe.

Frequently just after sunset, Rommel's Luftwaffe squadrons would come roaring in from the south and strafe the area enroute to Cairo or Suez Canal targets. Eighty miles to the west lay our defense provided by nature, the Qattara Depression, and extending north from its extreme eastern rim to the Mediterranean, Rommel's Afrika Korps and Montgomery's Eighth Army lay in the sand, pushing and resisting each other's pushes along the entire line. They reminded one of two mighty wrestlers, tired and worn from years of struggle but neither daring to give in.

This was before the Battle of Alemein and only those who were there know how disastrous the loss of that inevitable coming battle could be to the entire outcome of the war. Failure for the Allies would have meant the closing of the giant pincers of which Rommel's Afrika Korps was one side and the other side the German forces pushing the Russian Armies back in the Caucasus almost to the Iranian Border.

In the Tura Caves

Back in the caves, carved out thousands of years ago by the rulers of Egypt to obtain stone for building the Pyramids, we go into a scene quite different from

SAKKARA SPHINX AND PYRAMID

that on the desert's surface. Countless electric lights, operated by an underground plant, brilliantly illuminate huge cavern rooms which, due to their 150-foot cover of solid rock overhead, maintain a constant temperature of about 65 degrees.

Down this corridor a row of partitions separates the offices which house the administrative nerve centers of this underground enterprise. Telephone lines as well as electric light and power lines are carried on brick or stone pillars; wood is too scarce to use for this purpose.

In one huge room over one hundred Palestinian draftsmen are preparing the drawings for each of the colors required in a 1/25,000 series up ahead of the present battle areas. The Palestinian group includes both Arabs and Jews, although the personnel is predominantly Jewish.

Beyond and around a bend in the rock, we come to another large drafting group, this time Indian and English Survey troops. (The term Survey, in the English Army, covers all phases of mapping and reproduction work.)

Ahead we can see a line of presses which operate on three 8-hour shifts, when the circumstances and supplies permit, and reduce to a lesser effort only as a lack of available personnel, map compilation material, and reproduction supplies make such a reduction mandatory.

In another room scores of uniformed figures check maps already available against the latest aerial photographs of the area and against intelligence information sent in by agents co-operating behind the lines.

Still other caverns contain stereoscopic equipment, photographic laboratories, copy cameras, and supplies, including chemicals, colors, inks, paper, and equipment.

Difficulties of Making Maps in the Desert

The supply of essential materials to permit map reproduction was an ever-

present bottleneck and always a variable one. Materials had to be shipped from England or the United States around the Cape of Good Hope and up the Indian Ocean via the Red Sea to Suez and adjacent ports. This voyage in a Liberty Ship required 7 to 8 weeks, *if* the ship actually survived U-Boat and surface raider attacks in the Atlantic and Japanese sea and air attacks in the Indian Ocean. This meant that supplies had to be ordered at least 3 to 6 months ahead of time of expected usage, and shipments had to be sent split up on various ships so that the loss of one ship would not completely stop the mapping operations.

In some instances lenses necessary for copy cameras or other photographic work were actually ground by the faculty members of the Hebrew University in Jerusalem, Palestine.

Paper supply was a constant source of worry. With shipments being made from the United States, Britain, and India, enemy action resulted in the loss of a high percentage of these shipments and on many occasions forced the printing of maps on the reverse side of salvaged maps or maps captured from the Africa Korps.

There was a small but constant demand for maps printed on silk or linen for air force personnel flying over enemy territory and for intelligence personnel who were constantly being dropped by parachute behind the enemy lines. Maps of this type could be carried in a pocket as a handkerchief and no doubt on many occasions were used for that purpose. They also served as emergency bandages and have been used on occasion to tie up a prisoner.

Printing a multi-color map on silk or other cloth involves many difficulties which those of you familiar with map reproduction problems will instantly realize. With some materials these had to be produced individually by hand on a proving press.

There could be no standard procedure in the process of publication of any map until it reached the printing stage. In some instances it was a case of compilation based on old maps already available of varying scales, accuracy, and detail, supplemented by a study of aerial photographs and intelligence information to the extent that these were available.

In other instances maps available were too old, and detail too sparse, to give sufficient information and entire reliance had to be placed on aerial photographs with varying quantity and quality of control available, and on many occasions that control was either non-existent or non-available.

On occasions some control was obtained by personnel dropped behind the lines, but this procedure was not practical and, unless unusually fortunate, such missions were not too successful. Occasionally agents were successful in securing (stealing) the records of needed control from the occupying German or Italian forces themselves.

Mapping of enemy territory was not too simple a problem in this last war. The enemy for some reason seems to resent ground mapping parties operating in his domain, and a photographic plane, although not normally equipped for combat, is just as vulnerable to enemy pursuit ships or anti-aircraft fire as any other type of plane. So casualties may run rather high on assignments of this type.

Maps must be prepared, ordinarily, at least 6 months to a year ahead of the actual military operation. This means the map officers must guess intelligently where and when maps will be needed, in some instances before the army itself begins to plan specific operations. All maps produced must be constantly revised

and brought up to date. No map is ever accepted as without need of further revision and correction.

Down in this hole in the ground, maps were being made for the Battle of Alemein soon to come; for the landing and operations in North Africa still several months ahead; for Sicily-Italy-Southern France; and for other areas "just in case." So, out of these "bomb shelters" built thousands of years ago, came truckloads of maps to be shipped to the units needing them, some by truck, some by air, and some by water. The ancient Egyptians did not know in their day how much they would aid the cause of the Allies in World War II.

Aside from mapping, the Tura Caves also provided further assistance. In one was located a complete hospital, wards, operating rooms, kitchens, etc.; in another, huge quantities of air force supplies, engines, and parts; in others, the largest single storage of munitions in the theatre safely stored in its desert shelter.

The 512 Base Survey Company

Throughout the entire underground area one notices the quiet yet efficient movements of all the personnel who seem to be imbued with the same spirit, regardless of their own origin. "Our contribution must *never be too little or too late.*" The officers and men of the 512 Base Survey Company, Royal Engineers, who operate the underground mapping establishment, have indeed a record of which to be proud. In the fall of 1942 most of these men had already been serving there for over 4 years and up until VE Day, to my knowledge, this unit was still functioning.

Their life, for the 5, 6, or 7 years in the desert, was work, eat, and sleep, with only such recreational facilities as they could provide for themselves. Even in this they were not lacking and one of the most enjoyable entertainments I have ever witnessed was staged by both enlisted men and officers of this unit during off shift hours. Their best morale builder was, of course, the mail from home, wherever that might be.

An annual Donkey Derby became quite an event, looked forward to from year to year. Any enlisted man or officer who could persuade some Arab to rent him a donkey and who put up a 50 piastre ($2.00) entry fee was qualified for the Derby. The fact that no one, including the jockeys, could tell how fast, how far, or in which direction the donkeys would run, added to the enjoyment of the occasion.

So these men, who became proud owners of the title "Desert Rats" from their life in the sand and rocks, made their contribution to victory, not only at Alemein with their "Goings Maps" showing trails which men and vehicles might travel to avoid the mine fields, as well as natural obstacles, but that contribution carried on up to and including the defeat of both Germany and Japan.

Their contribution did not end there. Survey units were at the front with the Eighth Army. Surveys for artillery fire purposes and location of mine fields were actually carried out by Survey personnel in the "no man's land" between the two opposing armies.

Periodically both officers and men of these Survey units were killed, wounded, or captured in action. In one instance two Survey officers were captured by Germans, turned over as prisoners to Italians, shipped to Italy by Italian submarine, blown to the surface halfway across the Mediterranean by depth charges from a British destroyer, bombarded by that destroyer's guns after being forced

to surface and deserted by the Italian crew, the submarine was finally blown up by a hit from the destroyer's guns which released these two officers from the compartment in which they were prisoners. After swimming for an hour in the Mediterranean, following the submarine's sinking, they were picked up by the destroyer, brought back to Alexandria and were back on duty with their unit within a week from the date of their capture.

Many Survey personnel served as "navigators" for Long Range Desert Patrol Groups composed of about 150 to 200 men each, in vehicles. These Groups would drive down into the desert, navigating by solar and star observations, and come up into the rear of Rommel's Afrika Korps, raiding the lines of communications, taking prisoners for intelligence purposes, blowing up ammunition dumps, destroying bridges, air installations, and gasoline supplies. These L R D P's, as they were called, carried only enough supplies to reach their operating area. After that, they lived on the enemy by seizing the necessary food and supplies. Worn out vehicles were replaced by capture. These Patrols were usually gone for periods of 2 to 6 months at a time and as many as half a dozen were operating at one time. Radio contact was maintained with their own headquarters near Cairo.

All secret and confidential work was done by code identification. For example: "George" was the name given to one of the big operations. Conversation over telephones might sound like this: "George wishes to see you this afternoon," (meaning report to "George" Headquarters).

On one occasion, just before Alemein, a complete set of fake maps were printed, dated, and stored in a map depot which was captured by the enemy. These false maps caused the failure of a major attack against the Eighth Army by indicating routes which led German tanks and armored forces directly into prepared ambushes and minefields. So the map maker made his contributions to victory wherever he was. I doubt if any of them had more variation or more day to day interest than was experienced by the men who made Maps in the Desert.

The Military Middle East Theater

Due to the scarcity of trained mapping personnel and equipment, it had been decided some months before in a quiet conference between two engineer officers in Washington, one American and one British, to divide the world up into zones of responsibility for mapping. Thus, by mutual agreement, part of the world was assigned to the United States for mapping and the remainder to the British. Facilities were not available for duplication of effort, and even with this division the effort exerted by both partners in this mapping job was stupendous. It is still more to the credit of these two powers that in those frequent occasions which arose within a particular area of responsibility for which one was responsible, but was temporarily in difficulty, that the other made available at once, from its own scanty local reserve resources, enough of what was needed at the moment to meet the emergency.

The military Middle East Theatre included all of Africa, eventually, with the exception of the North African Theatre made up of Tunisia and Algeria. It also included all the area in Asia Minor over to and including Persia to the east, Turkey and the Balkans to the north, Yugoslavia and the southern part of Italy as well as the islands including Sicily and Crete.

Besides the area actually in the military theatre, the mapping agencies of one theatre would produce as much as their own capacity would permit for other theatres, on request. This further co-operation was most essential at times, particularly in the North African invasion, Sicily and Italy invasion, and the Normandy invasion.

The prevailing shortage, plus destruction by enemy action, of mapping personnel and equipment made such over-all co-operation mandatory if the essential map needs were to be met. Each theatre was constantly taking up the slack caused by battle loss of stocks, personnel, and equipment, not only in its own but in other theatres as well.

This example of the effectiveness of mutual co-operation in times of dire emergency might well be long remembered and the methods and spirit which made possible these accomplishments carried over into civilian life and peacetime activities.

No one ever loses by sincere mutual co-operation. All benefit and all are enabled to perform their own function more readily. Co-operation can never be a one way effort, it must be reciprocal. Too many organizations, including educational institutions and professional organizations, seek to become completely self-sufficient in all phases, resulting in a duplication of effort and a resultant thinning out of resources to be applied to each activity or field.

If this little narrative has any point or value beyond the recounting of experiences that are now history, it is the fact that only through carefully thought out co-operative effort can any individual or organization accomplish results in many varied fields without an extremely high loss of efficiency.

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"Photography in Science" Competition

THE Smithsonian Institution and The Scientific Monthly have recently announced a Second International Photography in Science Competition for 1948. Like the First Competition, held in 1947, its purpose is to show examples of the uses of photography in scientific research, especially those which provide scientific information unattainable except through the use of photography. All scientists everywhere, including those engaged in photographic research, are eligible to participate.

The competition is divided into two sections, (1) black-and-white prints, and (2) colored prints and transparencies. There will be first, second, and third awards, and five honorable mentions in each of the two sections. Awards will take the form of certificates suitable for framing.

The greatest weight will be given to entries that show novelty of application of photography to scientific research and originality of photographic technique. Eight entries, four in each category, may be submitted by each contributor.

Entries will be received by the editor of The Scientific Monthly from July 26 to August 16, 1948, inclusive, and will be judged on August 21, 1948. Membership in the American Association for the Advancement of Science is not required and there is no entry fee. Further information and entry blanks may be obtained from The Editor, The Scientific Monthly, 1515 Massachusetts Ave., N. W., Washington 5, D. C.

The New 1:250,000 Scale Map of the Army Map Service

By JACOB SKOP
CHIEF, MAP DESIGN, ARMY MAP SERVICE

ONE of the items most susceptible to cartographic evolution is the medium-scale military map. This indispensable tool of warfare satisfies many special military needs, and every major change in military methods requires a comparable change in the design and content of the map. A hundred years of cartographic progress have been concentrated in the short period between World War I, with its relatively stable warfare, and World War II, with its island-hopping, swift invasions and distance-consuming armored thrusts. During this period the medium-scale map went through several changes, the culmination of which is the new 1:250,000 map of the Army Map Service.

The U. S. Army Strategic Map

Just prior to and during the first years of World War II, the generally accepted U. S. Army strategic map was at the scale of 1:500,000. An example of this was the 87-sheet Map of the United States prepared in 1938–39 by the Army Map Service, then known as the Engineer Reproduction Plant. If the warfare of World War II had been the same as that of World War I, the 1:500,000 map would have proven satisfactory. The knowledge gained through the experiences of World War I was reflected in the map's design and content, and certain features were added as a studied attempt to anticipate future developments in military methods. The foresight of the map's designers was commendable but, unfortunately, no imagination was vivid enough to cope with the revolutionary changes of the holocaust to come.

With the outbreak of World War II, the Army Map Service immediately began preparing maps of most theaters of importance at the scale of 1:500,000. As the global nature of the war became apparent, it soon became evident that such maps were inadequate for strategic purposes. The scale was too large to meet the needs of the over-all strategic planning of higher echelons, and too small to serve as a base for developing tactics in the several theaters. The 1:500,000 map was promptly abandoned and in its place were substituted two other maps; one at the scale of 1:1,000,000, and the other at 1:250,000.

The 1:250,000 map was adopted in 1942 and the early maps were prepared primarily to fill the planning needs of both joint high commands and theater commanders. Since the need for the sheets was urgent they had to be prepared in the shortest possible time. The sheets were small, covering only 1° of latitude and 1° of longitude, since it was compulsory that they be designed for printing on field presses whose maximum accommodation was 19¼ by 22 inches.

During the war, the Army Map Service prepared hundreds of sheets of this type, successfully answering the immediate demands of military needs. However, there were certain shortcomings in its design, especially with regard to road information and means of providing rapid terrain appreciation, and these became more and more apparent. Relief, shown by contours, was too detailed and road

data, having been generalized, were inadequate. The fine differences in elevations noted by contours were unimportant to the tanker and proved confusing rather than helpful. He was moving rapidly and had no time to study contours to determine formations. The locations and shapes of woodland cover were important, and convoys required a complete road classification both as to construction and width. The strategic map covering maximum distances approximately 60 miles in each direction was too small to be used as a "road map" for tactical units.

Thus, toward the end of the war, the basic medium-scale map was ready to undergo several significant changes. The Army Map Service initiated a study to design a map at the same scale but which would satisfy the needs of both the strategic planners and the majority of mechanized tactical units. It was, of course, understood that certain compromises would have to be made. The new 1:250,000 map was the result.

Features of the New Map

Size and layout.—The size problem was easily solved, for with the end of the war the Corps of Engineers adopted new field presses whose maximum printing size is 21 by 27 inches. It was further decided that in the future maps at the scale of 1:250,000 would be printed only by base plants, all of which are equipped with presses which can accommodate all size demands. When used for strategic purposes, a map must follow a stable layout with neatlines being even degrees of latitude and longitude. This facilitates ready reference with companion series of the next larger and next smaller scales, and likewise allows sheets to be butt-joined to serve as a wall map. On the other hand, as a "road map" it is important to include as much area on one sheet as possible. All these factors were considered, resulting in this solution: Sheets between 0° and 60° latitude are 1° north-south by 2° east-west, those between 60° and 72° are 1° by 4°, those between 72° and 76° are 1° by 6°, and beyond 76° the sheets are 1° by 8°. This follows the plan for longitudinal increase of the 1:1,000,000 sheets with departure from the Equator. In all cases a 1:250,000 sheet includes 1/12th the area of the 1:1,000,000 sheet within which it falls.

Since the layout of the 1:250,000 sheet is correlated to that of the 1:1,000,000 sheet, the numbering system is likewise correlated. The 1:250,000 scale sheets are numbered the same as the 1:1,000,000 scale sheets in which they fall, but with an additional Arabic numeral from 1 to 12 appended, which locates them within the small-scale sheet. (*See* fig. 1.) The advantages of such a numbering system over an arbitrary one are obvious.

Place names and built-up areas.—It was found that it was desirable to retain the maximum of political and geographical names shown on the old strategic map and also to retain the number of and distinctions between populated places, as this information is useful for all military purposes. An improvement is the delineation of built-up areas which are shown in their true shapes, plotted to scale, and printed in distinctive yellow coloring. Each sheet has a "back-up" consisting of diagrammatic plans of important towns appearing on the face of the map with each town retaining its true outline. Data in the back-up plans include principal landmarks for orientation purposes; through routes are labeled and connected with built-up environs.

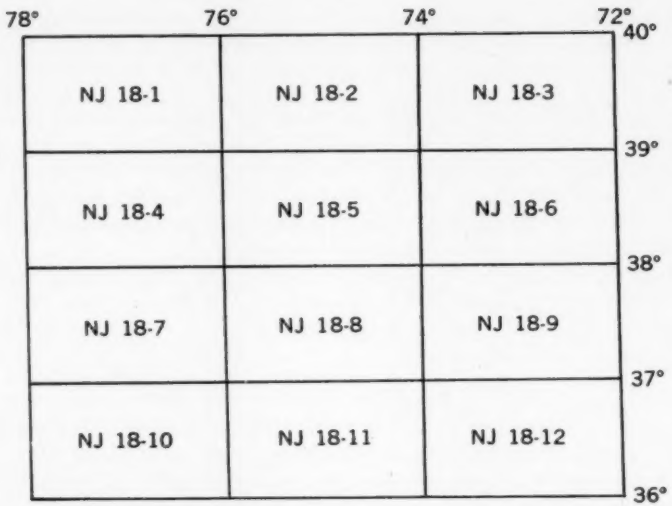

FIGURE 1.—Identification system used on new map series.

Railroads and roads.—While railroads are important only as landmarks for road map purposes, complete information for this item is required for strategy. Consequently, the detailed gage and track classifications of the old strategic map are retained on the new map. It was found that the weights and gages of these symbols could be reduced without sacrificing the legibility of the map, resulting in a more satisfactory balance between the portrayal of roads and railroads.

Roads are of prime importance to mechanized units and for planning. A comprehensive study was made of roads, resulting in the adoption of a universal classification system which made for consistency of interpretation regardless of area. On the new 1 : 250,000 map, the road pattern includes all roads, regardless of classification, which are important to the transportation scheme. Roads are emphasized, being delineated by black casings which contain red fills denoting their classifications; road objectives at sheet limits indicate the distances and directions of the next important towns in adjoining territories. A complete road classification is made, including the width and constructon, with each class being especially defined for military use.

Relief and vegetation.—The representation of relief created the greatest problem. It was impossible to dispense with contours since they were needed for strategic and engineering studies and would be useful in conjunction with Radar. But at the same time, the principal terrain differences had to be made readily apparent to mobile units. The solution is a unique representation of relief by a combination of hill shading and contours. These are combined on a common press plate and printed in a pleasing gray which does not minimize more important features. Developed for pictorial effect rather than topographic precision, the shading affords a quick and fairly accurate appreciation of terrain. Exaggerated perspective and the arbitrary application of light and shade result in a comprehensive, yet detailed, portrait of prominent land formations. Proper

rendition of shaded relief depends on the talent of an artist-cartographer and the careful processing of this initial effort through the various phases of photolithographic reproduction. In this procedure, color is an important factor. Warmth of tone must be balanced against the dominance of the map's other more important features. Shaded relief must be sufficiently strong to overcome the threat of obscurity from the overprinted green denoting vegetation cover. The scheme has its desired effect, for at first glance only the shaded relief is apparent. A second glance reveals the contours standing out clear and sharp.

The addition of woodland cover was a requisite, for this information is almost as useful to planning units as it is to operating units.

Projection and coverage.—The map is based on the transverse Mercator projection which accommodates with a minimum of distortion the new 10,000-meter universal transverse Mercator military grid. For economy, the grid is printed together with the drainage in blue.

The First Sheet of the New Map

The "Washington" sheet, NJ 18–4 recently off the press, is the first sheet published by the Army Map Service according to the new design and specifications. It is expected that 465 sheets of this type covering the entire United States will be published, eventually to replace the 1 : 500,000 strategic map. In addition, many sheets will be prepared to cover foreign areas of strategic importance.

The new map has received much favorable comment and appears to be a totally satisfactory replacement for the obsolete strategic maps which were the standards of the last war. Although the design is finalized, a receptive attitude is being maintained and changes will be made when necessary to keep pace with any new developments in military tactics.

* * *

New Machine Reproduces Drawings at Mimeo Speed

Photo-reproductions of text or drawings at mimeograph speed are the revolutionary promise of a new duplicating method on which U. S. patent 2,427,443 has just been issued in Washington to Theodore R. Cochran of Glen Ellyn, Ill.

Key to the method is the peculiar photosensitivity of a series of organic compounds of tungsten, molybdenum, and related metals. Irradiated with light just on the borderline between high violet and near ultraviolet, these compounds turn dark without further treatment of any kind; yet they are inert to ordinary daylight and lamplight.

In a preferred form of the duplicator, a transparent or translucent negative or master copy is secured to the rotating drum of a mimeograph-like machine. At the bottom of the turn, it passes under a bar-lens, behind which is a tubular mercury-vapor lamp. An automatic paper feed passes under it, on each turn, a sheet of paper coated or impregnated with the photosensitive metal salt. The image appears at once, and is permanent.

Rights in the patent are assigned to the A. B. Dick Company, manufacturers of mimeograph equipment.—*Science News Letter,* September 27, 1947.

Azimuths in a Hurry

By C. A. WHITTEN

CHIEF, SECTION OF TRIANGULATION, U. S. COAST AND GEODETIC SURVEY

EDITOR'S NOTE.—The method of determining an astronomic azimuth described in this paper was used by Lieut. Comdr. J. S. Morton in the Southwest Pacific while attached to the U. S. Marine Corps during the recent war. Comdr. Morton states:

"One of the problems for our mobile artillery, raised by our participation in a global war, was the development of a method of simple and quick determination of azimuth in areas where we had no control surveys. The available equipment for this work was generally a surveyor's transit with verniers reading to 1 minute or to 30 seconds. For the purpose at hand a tolerance of about 3 minutes was considered satisfactory.

"The method devised by Mr. C. A. Whitten proved to be very satisfactory. The observations required only a few minutes, no computation was involved as the values could be taken directly from the tables (for equatorial areas graphs were supplied in addition to the tables), and the accuracy was within the allowable tolerance.

"When time was critical some liberties were taken with the prescribed observational procedure. With the instrument in good adjustment a single measurement of the horizontal angle between a mark and the star, a single measurement of the altitude of the star, and a scaled latitude to the nearest minute gave results within the allowable tolerance. Two or more stars were always used as a check on identification of the star and to catch any blunders."

ONE OF THE SURVEYING PROBLEMS of the early part of the war was quick determination of azimuth with fair degree of accuracy. A proper balance between speed, accuracy, and simplicity was obtained through the further development of a method already well known. The azimuth of a star in the east or west can be determined by measuring the altitude at the same time the horizontal direction is being observed. For a given star its observed altitude and the latitude of the observer are the only variables in the equation of azimuth. Thus, for any particular star a table can be computed which will show the azimuth of that star for various latitudes and altitudes. Mean refraction corrections can be applied so that the observed altitude may be used directly in the tables. This has been done for 25 of the brightest stars of the Northern Hemisphere for use between 10° and 60° north latitude. Similar tables have been published for use in southern latitudes with the values for 20 of the brightest stars of the Southern Hemisphere. These tables were computed for the positions of the stars in 1945.* They can be used until 1948 without much loss of accuracy. After that, tables based on 1950 positions should be used.

The publications contain star maps which will aid in the identification of the stars. After one has learned to recognize a few of the stars in the tables he will find it easy to identify the others that are used in the tables.

METHOD OF OBSERVATION

A brief description of the actual method, and an example of the record and computation, will illustrate what can be done with very little experience or training in astronomic work.

* See Appendix for list of publications containing star azimuth tables.

After the transit is carefully leveled, it should be pointed toward the mark with the verniers reading 0° and 180°. The lower motion is kept clamped during all of the observations. Then loosening the upper motion, the telescope is pointed toward the star to be used. When the star is found in the field of view, the horizontal wire is set "ahead" of the star and then the vertical motion clamped as well as the horizonal motion. The star is then bisected with the vertical wire and "tracked" by following the star by using the slow motion. The star will then appear to move in a vertical path. The "tracking" is maintained until the star crosses the horizontal wire. At that instant all motion of the instrument should cease. The vertical and horizontal circles are read and the instrument reversed, lower motion still clamped. The star is again observed in the same manner with a record of the vertical and horizontal circle reading. The telescope is then pointed toward the mark and the horizontal circle read.

The horizontal angle between the mark and the star and the altitude of the star can be computed from the readings. This completes one set. The same star or other stars may be used for as many sets as desired. It is a good plan to use two or more stars as a check on the identification of the stars.

Computation of Azimuth

Having the angle between the star and the mark, the next step is to determine the angle of the star from north. The tables contain this information. This angle may be obtained by interpolating first for the latitude of the observer and then for the observed altitude of the star. This process is known as double interpolation. The final value is the angle of the star from north and is a clockwise angle when the star is east and counterclockwise if the star is west. Thus, the angle must be used with the correct algebraic sign when the azimuth of the mark is computed.

The record and interpolation consist of the following:

Record of Observations

Vega—east (from compass or approximate orientation)

Angle (mark to star)	36°12′
Altitude of star	44°27′ = 44°.45
Latitude of instrument	12°43′ = 12°.72

Azimuth Values from Tables for Star Vega

Latitude	Altitude 44°	Altitude 45°
12°	46°51′	46°13′
13°	47°58′	47°23′

Star East—Angle measured clockwise from North
Star West—Angle measured counterclockwise from North

By double interpolation from table for latitude 12°.72 and altitude 44°.45:

Azimuth of star = North 47°23′ East.
Azimuth, instrument to mark = 47°23′ − 36°12′ = North 11°11′ East.

This method may be used in the United States if an azimuth accurate to a couple of minutes of arc is suitable for local control or checking purposes. With

a little experience one will soon see that, when necessary, it is possible to obtain azimuths in a hurry.

APPENDIX

The following U. S. Coast and Geodetic Survey publications contain star azimuth tables:

G–47, Star Azimuth Curves and Tables for Latitudes 15° North to 15° South.
G–48, Star Azimuth Tables and Graphs for Latitudes 10° to 60° North.
G–49, Star Azimuth Tables and Graphs for Latitudes 10° to 60° South.

Report of Astronomer Royal for 1947

THE REPORT FOR 1947 of the Astronomer Royal to the Board of Visitors of the Royal Observatory at Greenwich, is of considerable interest. The trek from Greenwich to Herstmonceux Castle in Sussex has already started; the Nautical Almanac Office is already established there. It is pleasant to note that a part of our grudgingly paid taxes has been applied to a very laudable object. To commemorate the tercentenary of the birth of Sir Isaac Newton a 100-inch aperture reflecting telescope is to be built with funds provided by the Chancellor of the Exchequer. This instrument will surpass any that we have at present and its provision is a none too hasty recognition of the fact that astronomical bricks cannot be produced without a certain amount of optical straw. Unfortunately the Report has to complain of continuing printing difficulties that have caused delay in the publication of the *Nautical Almanac*, the *Abridged Nautical Almanac* and the *Air Almanac*.

In the navigational field, a good deal of work has been done on charts for use with the Decca system of navigation. As the Report says, "this work, while of no astronomical bearing, is peculiarly suitable for the experience and equipment of the office and is a natural extension of the astronomical navigational work." Out of fifty charts that are required, sixteen have been completed; and it is anticipated that the remainder will be completed within a year. Another point worth notice is that a position—Longitude 94½° West, Latitude 73¼° North—has been adopted as the position of the North Magnetic Pole. The Report states "there is strong evidence that the North Magnetic Pole is considerably to the North of the Ross-Amundsen position, hitherto adopted."—*The Nautical Magazine*, October 1947.

Institute of Numerical Analysis is Established

PLANS HAVE BEEN COMPLETED for the establishment of one of the newest units of the National Bureau of Standards—the Institute of Numerical Analysis—at the University of California at Los Angeles, according to an announcement by Dr. Edward U. Condon, director of the Bureau.

One of the giant high-speed electronic computing machines, now under development by the Bureau of Standards, will be installed at the institute when completed. These computers will solve problems that are now out of the reach of scientists. Design specifications call for high memory capacity and automatically sequenced mathematical operations from start to finish at speeds attainable only with electronic equipment.

The institute has two primary functions. The first is research in applied mathematics aimed at developing methods of analysis which will extend the use of high-speed electronic computers. The second is to act as a service group for Western industries, research institutions, and government agencies. The service function will include not only the use of the machines for problem solving but also assistance in the formulation of problems in applied matheatics of the more complex and novel types. Service operations are to be initiated immediately, using the latest types of commercially available computing equipment.—*Civil Engineering*, October 1947.

Old Landmark Recovered at U. S. Naval Academy

By B. EVERETT BEAVIN*

THE Chesapeake Bay, with numerous harbors and ports, was the scene of some of the earliest precise triangulation executed by the U. S. Coast and Geodetic Survey, which in early days was known as the Coast Survey.

In 1834, a primary base line was measured at Fire Island on the southern side of Long Island, New York; a second base line was measured on Kent Island on the Chesapeake Bay opposite Annapolis in 1844. Some triangulation was executed during the years 1842 and 1843 in the vicinity of the Patapsco River. However the initial first-order direct measurements in Maryland were made at station Finlay in Baltimore County during August and September 1844, by James Ferguson, using a direction theodolite. The connection between Fire Island and Kent Island base lines was not completed until 1848.

The report to Congress of the second superintendent of the Coast Survey, A. D. Bache, for the year 1845, showed that a first-order triangulation station was established in 1844, by James Ferguson, on a hill on Greenbury Point between the Severn River and Mill Creek, across the river from the Naval Academy, on ground then owned by Captain Lemuel Taylor. The site now is occupied by the Naval Academy Golf Course and the triangulation station is in the fairway about 50 feet south of the seventeenth green. The station, which was referred to in early reports as Taylor's, is now carried in the records of the Coast and Geodetic Survey as Taylor, 1847. Other stations originally sighted upon from Taylor, 1847, include Kent Island North Base, Kent Island South Base, Marriott, Linstid, and Taylor Astronomic Latitude Station which was about 10 feet north of the triangulation station. Taylor, 1847, was marked by a granite post with a hollow earthenware cone 14½ inches high, 6½ inches inside top diameter and 12½ inches inside lower diameter placed as a subsurface mark.

Taylor, 1847 served as the local triangulation control for the earliest Coast Survey chart of the Severn River and Annapolis Harbor which was published in 1846. This was one of the earliest accurate charts prepared of the vicinity. In addition to soundings, it contains a great deal of information concerning currents, magnetic variation, tidal notes, and sailing directions for entering the harbor. An original printed copy of this chart is on file in the Naval Academy Museum.

On October 10, 1845, the U. S. Naval Academy was established on the south shore of the Severn River. The academy was quite small, there being only 56 midshipmen in attendance on January 1, 1846. Some idea of the appearance of the Naval Academy and the City of Annapolis at that time may be gained by inspecting the accompanying reproduction of a bird's-eye view of Annapolis published some time after 1860.

In 1859, the Taylor, 1847 station was searched for and reported lost. In the records of the Coast and Geodetic Survey there is a notation, "Searched for by Ensign E. A. Anderson and no sign of the triangulation point found. The place

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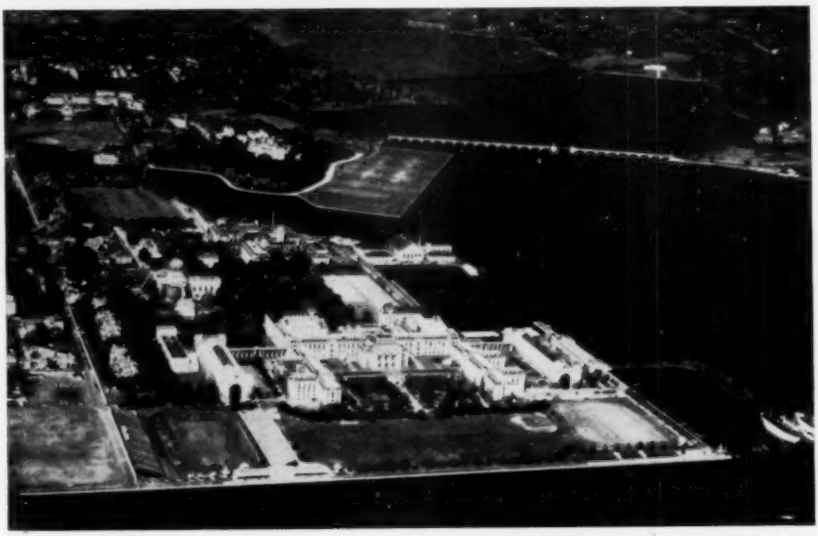
* Project Engineer, J. E. Greiner Co., Consulting Engineers.

CIVIL WAR SKETCH OF THE NAVAL ACADEMY
A triangulation station established in 1847 by the U. S. Coast and Geodetic Survey has just been rediscovered on the Academy golf course.



Official U. S. Navy Photograph

PRESENT-DAY VIEW OF THE NAVAL ACADEMY
This view is photographed from almost the same position as the Civil War sketch.

was marked by cedar stumps that have been dug up and thrown away by Negroes while searching for supposed treasure buried by the U. S. Government." This may account for the destruction of the surface mark. Apparently rumors started as easily in those days as they do now.

From 1859 on, the station was carried in the records of the Survey and its position adjusted as various computations of the precise triangulation net were made. Its latitude and longitude appear in *Triangulation in Maryland*, published by the Coast and Geodetic Survey in 1925. As far as is known, however, the station never again was recovered until 1946.

The recorded latitudes and longitudes of Taylor, 1847 are as follows:

North American Datum—North 38°59′48″.390, West 76°27′55″.906
North American 1927 Datum—North 38°59′48″.034, West 76°27′56″.076

The rectangular coordinates of Taylor, 1847, on the Maryland Grid System are: X (East) 951,889.60; Y (North) 424,109.44.

In October 1945, the U. S. Navy, Bureau of Yards and Docks, authorized the J. E. Greiner Company, Consulting Engineers, Baltimore, Maryland, to make extensive control, topographic, and subsurface surveys for naval activities in the Annapolis area.

Many miles of precise triangulation and traverse were run late in 1945, starting from U.S.C. & G.S. stations Green, 1932, Horn, 1910, and Cliff, 1932. One loop of precise traverse passed along a road near the plotted position of Taylor, 1847.

It was felt that final adjustment should not be made to the 1945 surveys without exhausting the possibility that a first-order station still existed within the area. Therefore, it was decided that a further search should be made, either to recover Taylor, 1847, or definitely to prove its destruction.

The azimuth and distance from a near-by station, Twogreen, 1945, were computed and the course run out. On January 14, 1946, a careful excavation was begun, and about 8 inches below ground the top of the earthenware cone was uncovered. The cone was found to be in perfect condition, but so close to the surface that it was removed and the station re-marked for permanency. An 8-inch concrete monument 4 feet long was set in concrete exactly in its place. The top is marked by a bronze disc bearing the letters USNA (United States Naval Academy) and stamped "Taylor, 1847–1946."

Several reference monuments, of similar construction, have been installed nearby in order to preserve the first-order triangulation in this vicinity in case Taylor, 1847–1946 ever becomes lost. The nearest reference monument was named Ferguson, 1946, for the surveyor who established the station 102 years ago.

The station was found within 1½ inches of the computed position (which includes the uncertainty inherent in the 1945 surveys), indicating that later second- and third-order triangulation in the vicinity has not deviated far from the original control. If one stops to consider that lower-order triangulation has been extended into the Severn River several times since 1844, due to destruction of monuments by erosion and by the works of man, it is all the more remarkable and a tribute to the care and skill exercised by the U. S. Coast and Geodetic Survey that such a close tie should be made when the station finally was recovered.

The accompanying aerial photograph shows the Naval Academy and part of the city of Annapolis as they exist today. The changes that have taken place during the 100 years since the triangulation station was installed are indeed amazing. Probably the scene will have changed more remarkably 100 years hence.

Topographic Surveys

Progress Report of the Committee of the Surveying and Mapping Division on Topographic Surveys

EDITOR'S NOTE.—This is the second and concluding installment (the APPENDIX) of the Report on Topographic Surveys which was prepared by a committee of the Surveying and Mapping Division of the American Society of Civil Engineers. The first installment appeared in the January–June 1947 issue of SURVEYING AND MAPPING.

RECOMMENDED STANDARD SPECIFICATIONS FOR TOPOGRAPHIC SURVEYS AND MAPS

SECTION A. GENERAL SPECIFICATIONS APPLYING TO ALL SURVEYS AND MAPS

1. *Datum.*—On all surveys, where possible, horizontal position is to originate from, and be closed upon, existing government control. Vertical position is to be referred to sea level datum, as established by government bench marks. When government or state control monuments are within 5 miles of the project, the surveys should be tied to this control.

2. *Coordinate system.*—Horizontal position is to be referred to a rectangular system of coordinates, the State Plane Coordinate System where possible. If this is not possible, then an assumed value for the zero of coordinates is to be used. The azimuth of the axis is to be referred to the true meridian, determined either by observation on Polaris or on the sun as directed by government bulletins or modern textbooks on surveying.

3. *Map drafting.*—Maps are to be drawn on standard sheets, the actual format of which shall be predetermined. The map is to show a rectilinear projection, the grid lines of which are to be spaced 5 inches apart. The edges of the map shall be parallel to the grid system. Map titles are to be placed in the lower right-hand sheet corner between the neat line and the cutting line. Map titles are to show plainly whether position is referred to the State Plane Coordinate System and to sea level datum or whether these are assumed. If position is referred to the State System, the title must designate the name of the control point to which the survey is tied and the coordinate values and the elevation. This is important in case there should be later adjustment of these values by government survey bureaus. All maps must carry the date on which made, the name of the person who made them, and the name of the person or persons responsible for accuracy.

4. *Station numbering.*—Each control station in the field shall be numbered on the field guard stake when it is set and this number, shown in the map, shall designate the station. The numbers are to be continuous in the order in which the station has been established. There is to be no duplication of station numbering on a project. Should an error be made in the numbering which gives the same number to two stations, the second station so numbered may be designated by adding to the number a letter of the alphabet. There is to be no changing of

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station numbering after the station has been observed, by either transit or level party.

5. *Field survey methods; control system.*—Angular closure errors of triangulation and traversing, and closure errors of level circuits, shall be checked in the field and shall be shown clearly in the notebooks. Traverses and levels shall be run in closed circuits. All angles observed on traverses must be doubled and the mean of the double value is to be used. All chained distances are to be checked by an independent method of measure (such as stadia) to guard against any miscount in chaining. These readings are to be recorded. Where discrepancies (indicating chaining error) between the chained distance and the stadia reading occur, the distance must be rechained at once. The correction made as a result of rechaining is to be placed under the original distance, and a line drawn through the erroneous one. There is to be no erasing of the original notes either of chaining or of the stadia reading.

6. *Notebooks.*—Notebooks are to be filed in the office of the Engineer of Surveys. Field notes must show, on each page, the name of the party chief and personnel of the field party, the type and location of the work, the weather, and the date. The book is to be clearly indexed. Each book is to be labeled, indicating the type of work, and is to be numbered consecutively for each class of work. Instrumentmen must take particular care that the station designation in their notebook is the same as that shown on the station "guard stake" on the ground. Computation books must designate clearly the character of each computation, the date, by whom made, by whom checked, and the page and number of the field book from which the original data were obtained. This information should be shown on each page. The book must be fully indexed. A bench-mark book must be kept showing the adjusted elevations of all bench marks, with a description of each bench and showing the page and number of the level book in which the elevation was determined.

7. *Computations.*—All computations are to be checked by an independent computation by a different individual before results are accepted.

8. *Monumentation.*—Control stations are to be monumented. Monuments must be carefully set, well tamped, and allowed to settle for at least 3 or 4 days after setting before either traverse or levels are run over them. It is preferable that they not be run over until there has been a rain. Where speed is such a factor and rain may not be waited for, then the earth around the monument should be well watered and tamped at the time of setting the monument. Monuments should at least be long enough to extend below the frost line, and should be 5 inches or more in diameter at the top, with a brass plug 1 inch in diameter and 3 inches long centered in the monument top. The plug is to be either flush with the concrete or slightly countersunk. This brass plug is designed to include the mark indicating the exact point of a station and the station numbering or designation. The base of the monument should be as large as, or larger than, the top. Where soil conditions are such that the use of a concrete monument is not practicable or desirable, 2-inch galvanized pipe with a cap screwed on for the upper end may be used.

9. *"Site" and "block" plans to show control stations.*—The coordinate grid, horizontal control stations, and bench marks are to be shown in all project maps and plans. This is of special importance concerning "site" and "block" plans. This information is vital to speed and accuracy in the subsequent location work.

10. *Horizontal and vertical control.*—(*a*) A system of monumented horizontal control traverses is to be established originating from, and closing upon, existing government control points. The error of closure of the traverse circuits shall not exceed (before adjustment) 1:10,000 for second-order traverse and shall not exceed 1:5,000 for third-order traverse. If the purpose of the survey is such that control of a lower order will suffice, the control points need not be monumented.

(*b*) In running traverse, a tape or chain should be used whose length has been determined by the National Bureau of Standards when supported at each end and when supported throughout. The temperature of the tape during the chaining operation must be taken and proper temperature correction made. For proper slope chaining between "bucks," the elevation of each buck must be determined and chained lengths must be reduced to horizontal. Tension scales must be used to insure that the pull designated by the Bureau of Standards is maintained. The tension scales should be tested and adjusted every 3 days. The springs of these scales weaken quickly and must be kept in adjustment. The field notes should show the tape number of the tape used. Should the tape be broken, another standardized tape must be used and the notes must show clearly the station number where this change was made.

(*c*) The transit used should be in first-class condition. It will be found economical to use an instrument, the least count of whose vernier is not greater than 20 seconds, in which case the angle is to be doubled and the mean value used. If the transit used reads to the minute only, the mean value must be determined by six repetitions.

(*d*) Since control usually is to serve as the basis for all the subsequent surveys and maps needed on the project, the selection of its frequency and location must give due weight to this diverse need. In areas where there is to be detailed topographic mapping, and probable intensive development, the lines of control circuits should not be more than from 2000 feet to 2500 feet apart in one direction but may be of any convenient dimension in the other direction. Control points should not be more than from 800 feet to 1000 feet apart along the line of the circuit and must be intervisible. Where topography is to be taken by the planetable method, a layout of the planetable sheets should first be made, and the control circuits, near the sheet border, should be so selected that the line may be platted on both sheets.

(*e*) Where control is to serve for general topographic surveys and for controlled mosaics only, the control circuits may be much farther apart. These larger circuits may be cut up by stadia lines such as may be needed to maintain the specified map accuracy, where the control is for the combined planetable aerial photography method of mapping. The control points should be at or near identifiable picture points, such as right-angle intersections of roads, fences, and streams. The control party should have copies of the contact prints, and mark upon these prints the identification of the control points as located. Transit-stadia lines run for this purpose should have an accuracy of closure on the primary control of 1:1,200.

(*f*) As nearly as possible, in the interest of speed and accuracy, control circuits should follow existing roads and easy grades but should avoid traffic interference. Control stations should be so selected as to be least subject to destruction from possible road widening or other construction. The monuments should be

protected by two or more guard posts at least 3 feet high.

(*g*) Vertical control shall consist of levels run in circuits, the closure error of which shall not exceed 0.03 X $\sqrt{M}$ feet (M being the distance in miles). The elevation of each traverse station monument shall be determined. These points must be in circuit (turn points) and may not be side shots. Other permanent bench marks should be set at frequent intervals.

SECTION B. SPECIFICATIONS FOR GENERAL TOPOGRAPHIC MAPS

In addition to the general specifications applying to all topographic maps, the following specifications shall apply:

1. *Map scales.*—General topographic maps may be at scales varying from 1 inch equals 400 feet to 1 inch equals 1000 feet, and at contour intervals varying from 5 feet to 10 feet. The selection of the proper scale and contour interval is controlled by: The character of the terrain, the density of the culture, the size of the area, and any special "project" considerations. The map is to show the important physical features such as roads, railroads, streams, houses, fences, and cleared and timbered areas. Elevations are to be shown by contours and by spot elevations—the latter to be at road intersections, bridges, water surfaces, summits, and depressions.

2. *Accuracy.*—Distances from the nearest control point, of definitely recognizable points as platted on the map, shall not be in error by an amount to exceed 0.1 inch on the map scale. The contours shall portray the general topographic shapes, and elevations determined by interpolation from the contours shall not be in error by an amount exceeding one contour interval. Spot elevations shown in the map shall be correct within an amount, in feet, represented by one-quarter contour interval.

3. *Control.*—A system of horizontal and vertical control must be established to regulate the accuracy of the map, as described for horizontal control in Section A-10. When the need for the map is immediate and speed is so urgent that a complete system of primary control cannot be waited for, a circuit of primary control, both horizontal and vertical, should be run. This should be cut up by circuits of secondary control which may be run by transit-stadia method. The primary circuits must be so selected as to control and keep the secondary circuits within the specified limits of map accuracy. These secondary circuits should originate from, and close upon, points located by the primary control. The error of closure should never exceed 1:1,000 and should average 1:1,200 or better. To maintain the specified map accuracy which limits error of position to 0.1 inch on the map scale, no such secondary control circuit should be more than 7 miles long. Levels of the type known as "flying levels" should be run over the secondary control circuit, and the error of closure on the primary control must not exceed 0.3 foot.

4. *Map tests and criteria of acceptability.*—To determine whether surveys and maps, procured under contract, comply with the specified accuracy requirements, they are to be tested either by check profiles or by area tests, or by both. The test surveys are to originate from, and close upon, control points. The test profile is to be not less than 3000 feet long. The area tested shall be a strip not less than 600 feet wide (300 feet each side of a base or profile line) in which the location of contours within this area or elevations of selected points are determined. If 90

percent of the points tested comply with the accuracy specifications, the map shall be deemed acceptable. No map or map sheet shall be rejected unless two tests have been made. Each test is to be of a different area comprising the map or map sheet.

5. *Map drafting.*—The map shall be drawn on sheets of the best quality drafting paper obtainable—well-seasoned and double-mounted. Otherwise, the sheets may be on the best quality well-seasoned single mounted paper. The drawings shall be drafted in one color only (jet black waterproof ink). All lines must be clear, sharp, and distinct. Lettering shall be neat and legible and of a size to be readable in case of a 2 to 1 reduction. The inked sheets are to be copied photographically producing a film positive to scale. Prints may be made from these film positives by the ozalid or other dry reproduction processes. Reductions or enlargements to any desired scale may also be made from these positives.

SECTION C. SPECIFICATIONS FOR DETAILED TOPOGRAPHIC MAPS

1. *Map scale.*—Map scales for detailed topographic surveys vary from 1 inch equals 20 feet to 1 inch equals 200 feet, depending on the density of cultural features, character of terrain, and area involved. The contour interval is to be 1 foot or 2 feet.

2. *Data to be shown.*—The map sheets shall show: All control points and bench marks (with designating number and elevation), all roads, railroads, streams, fence lines, utilities, poles, isolated trees (12 inches or more in diameter), boundaries of timbered areas, rock ledges or boulders, wells, buildings, cemeteries, and any other physical data that will affect planning. In addition to the elevations shown by the contours, spot elevations shall be shown at all summits, bottoms of depressions, tops of banks, stream surfaces or water surfaces, road and railroad lines, breaks of grade, and at intersections and at bridges.

3. *Accuracy.*—Projection grids and control points shall be platted correctly to the nearest 0.01 inch on the map scale. The horizontal position of any definitely recognizable point shall be correct with reference to the nearest control point within 1/50 inch on the map scale. The contours shall express, faithfully, the relief detail and topographic shapes. In addition, elevations or profiles interpolated from the contours shall be correct within one-half the contour interval. Spot elevations shall be correct to the nearest 0.1 foot.

4. *Map drafting.*—The map shall be drawn on sheets of the best quality drafting paper obtainable—well-seasoned and double-mounted. Otherwise, the sheets may be on the best quality well-seasoned single-mounted paper. The drawings shall be drafted in one color only (jet black waterproof ink). All lines must be clear, sharp, and distinct. Lettering shall be neat and legible and of a size to be readable in case of a 2 to 1 reduction. The inked sheets are to be copied photographically producing a film positive to scale. Prints may be made from these film positives by the ozalid or other dry reproduction processes. Reductions or enlargements to any desired scale may also be made from these positives.

5. *Map tests and criteria of acceptability.*—To determine whether surveys and maps, procured under contract, comply with the specified accuracy requirements, they are to be tested either by check profiles or by area tests, or by both. The test surveys are to originate from, and close upon, control points. The test profile is to be not less than 3000 feet long. The area tested shall be a strip not less than 600 feet wide (300 feet each side of a base or profile line) in which the location of

contours within this area or elevations of selected points are determined. If 90 percent of the points tested comply with the accuracy specifications, the map shall be deemed acceptable. No map or map sheet shall be rejected unless two tests have been made. Each test is to be of a different area comprising the map or map sheet.

6. *Errors arising from paper distortion.*—To minimize errors arising from paper distortion it is recommended that maps be drawn on metal-mounted map sheets and that a method of reproduction direct from the map sheets be utilized. If situations should occur in which the use of tracing linen is unavoidable, errors arising from this use may be minimized if the following precautions are taken:

(*a*) Well-seasoned drafting paper of the best quality should be used.

(*b*) As soon as tracing linen is received, cut it into standard sheet sizes, and season it as well as possible by exposure to sunlight, moist, and dry weather; but do not hang the sheets up supported at one edge.

(*c*) Place the coordinate projection on both map sheets and tracing linen, before any other data are drawn on them. If this is done, the coordinate lines give a measure of the subsequent expansion or contraction which may be applied as a correction in plotting or scaling distance on the map, tracing, or blueprint.

(*d*) When tracing information from a map, keep those coordinate lines of the tracing linen in register with the identical lines of the original map, which surround the data being traced. In other words, work from the nearest coordinate lines, proportioning the discrepancy between the two coordinate grids in proportion to the distance from the grid lines. This can be done graphically by eye.

* * *

On Improvements in Survey Methods

SURVEYORS are prone to speak in superlatives when referring to any new development in methods or instruments: it is the best and most accurate; it far surpasses anything heretofore devised.

That this custom is not confined to the twentieth century moderns is strikingly illustrated by the following reproductions of several pages from The Compleat Surveyor, a text published in 1657 by William Leybourn, English surgeon, mathematician, and surveyor. Doctor Leybourn rises to the heights when he states on his title page, "the Plain Table being so contrived, that it alone will conveniently perform whatsoever may be done by any of the fore-mentioned Instruments, or any other yet invented, with the same ease and exactness; and in many cases much better."

A fifth edition of Leybourn's Compleat Surveyor was edited and enlarged by Samuel Gunn, and printed in 1722. Of Leybourn and his work, Gunn says:

"The author of this treatise was frequently employed in surveying, measuring, and mapping gentlemen's estates; as evidently appears from the several draughts by him drawn, and to be met with in almost every county in England.

"These qualifications alone recommended the first edition; and the book itself made way for three more afterwards."

THE COMPLEAT SURVEYOR,

Containing the whole ART of

Surveying of Land.

BY THE

Plaine Table, *Theodolite*, *Circumferentor*, *Peractor*,

and other Inſtruments

After a more eaſie, exact and compendious manner, then hath been hitherto publiſhed by any: the *Plain Table* being ſo contrived, that it alone will conveniently perform whatſoever may be done by any of the fore-mentioned *Inſtruments*, or any other yet invented, with the ſame eaſe and exactneſs; and in many caſes much better.

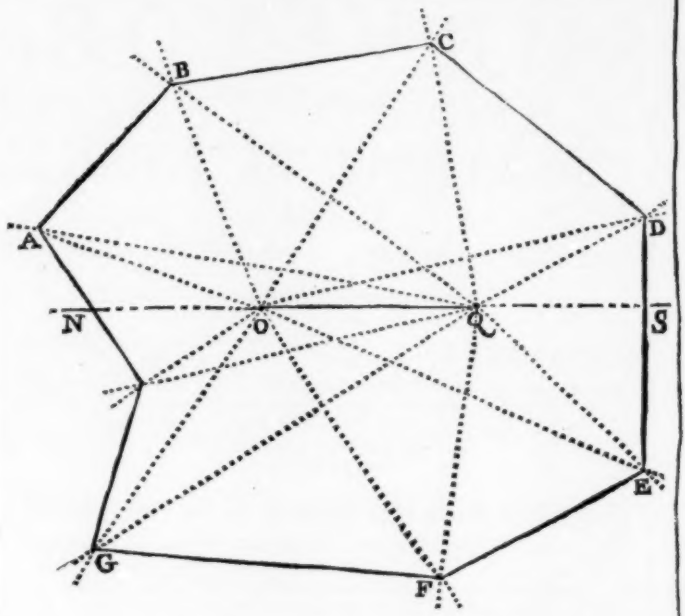
Together with the taking of all manner of Heights and Diſtances, either acceſſible or in-acceſſible, the Plotting and Protracting of all manner of Grounds, either ſmall Incloſures, Champion Plains, Wood-lands, or any other Mountainous and un-even grounds. Alſo, how to take the Plot of a whole Manor, to caſt up the conteut, and to make a perfect Chart or Map thereof. All which particulars are performed three ſeveral ways, and and by three ſeveral *Inſtruments*.

Hereunto is added a new way of *Surveying* of *Land*, by which a man may be ſatisfied whether his Plot will cloſe before he begins to protract the ſame, with the manner how to order ſuch Water Colours as are neceſſary for the beautifying of *Maps* and *Plots*; Alſo how to know whether *Water* may be conveyed from a Spring-head to any appointed place or not, and how to effect the ſame: With whatſoever elſe is neceſſary to the *Art* of *Surveying*.

The Second Edition, *with many* Additions.

By WILLIAM LEYBOURN.

LONDON,
Printed by *R.* and *W. Leybourn*, for *G. Sambridge*, at the ſigne of the Bible upon *Ludg*-gate-hill, *M. DC. LVII.*



CHAP. XXXI.

How to take the Plot of a Wood, Park, or other large Champion plain by the Plain Table, *by measuring round about the same, and making observation at every angle,*

HItherto we have shewed how the plot of any plain and even ground, or any small enclosure may be taken severall wayes, as being the easiest for a practioner to try experience upon, I now come to shew how the plot of any large Champion plain, or over-grown wood may be measured, for in such kinde of grounds the former directions will be of little validity, for the largenesse of the Plain, or the thicknes of the wood may many times hinder both your sights and measuring; therefore the best way to measure these kinde of Lands is to go about them, and make observation at every angle.

Sup-

Suppoſe the following figure A B C D E F G to be a large Wood or other Champion plain, whoſe Plot you deſire to take upon your Plain Table.

1 Place your Inſtrument at the Angle A, directing your ſights to the next angle at B, and by the ſide thereof draw a line upon your Table, as the line A B, then meaſure by the hedge ſide from the angle A, to the angle B, which ſuppoſe 12 Chains 5 links, then from your Scale take 12 Chains 5 Links, and ſet that diſtance upon your Table from A to F.

2 Remove your Inſtrument from A, and ſet up a mark where it laſt ſtood, and place your Inſtrument at the ſecond angle at B; then laying the Index upon the line A B, turn the whole Inſtrument about till through the back-ſights you ſee the mark which you ſet up at A, and there ſcrew the Inſtrument: then laying the Index upon the point B, direct your ſights to the third angle at C, and draw the line B C upon your Table, Then meaſuring the diſtance B C 4 Chains 45 Links, take that diſtance from your Scale and ſet it upon your Table from B to C.

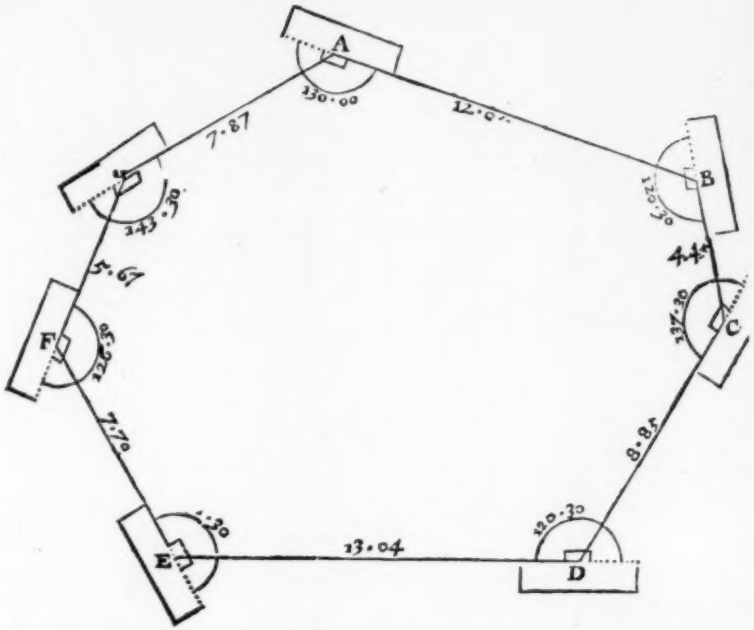
3 Remove your Inſtrument from B, and ſet up a mark in the room thereof, and place your Inſtrument at C, laying the Index upon the line C B, and turn the whole Inſtrument about till through the back-ſights you eſpie your mark ſet up at B, and there faſten the Inſtrument: then laying the Index on the point C, direct the ſights to D, and draw upon your Table the line C D then meaſure from C to D 8 Chains 85 Links, and ſet that diſtance upon your Table from C to D.

4 Remove your Inſtrument to D (placing a mark at C where it laſt ſtood) and lay the Index upon the line D C, turning the whole Inſtrument about till through the back-ſights you eſpie the mark at C, and there faſten the Inſtrument: then lay the Index on the Point D, and direct the ſights to E and draw the line D E then with your Chain meaſure the diſtance D E 13 Chains 4 Links, and ſet that diſtance upon your Table from the point D unto E.

5 Remove your Inſtrument to E (placing a mark at D where it laſt ſtood) and laying the Index upon the line D E turn the whole Inſtrument about till through the back-ſights you ſee your mark at D, and there faſten the Inſtrument: then lay the Index on the point E, and direct the ſights to F, and draw the line E F, then meaſure the diſtance E F 7 Chains 70 Links, which take from your Scale, and ſet it on your Table from E to F.

6 Remove your Inſtrument to F (placing a mark at E where it laſt ſtood) and lay the Index upon the line E F, turning the Inſtrument about, till through the back-ſights you ſee your mark ſet up at E, and there faſten the Inſtrument: then laying the Index on the point F, direct the ſights to G, and draw the line F G upon your Table, then meaſure the diſtance F G 5 Chains 67 Links, and ſet that off upon your Table from F to G.

7 Remove your Inſtrument to G (ſetting up a mark at F where it laſt ſtood) and lay the Index upon the line F G turning the whole Inſtru-



Inſtrument about, till through the ſights you ſee the mark at F, and there faſten the Inſtrument, then laying the Index upon the point G direct the ſights to A (your firſt mark) and draw the line G A, which ſhall paſſe directly through the point A, where you firſt began, if you have truly wrought.

In this manner may you take the plot of any Champion plain be it never ſo large, and here note, that many times hedges are of ſuch a thickneſſe that you cannot come neere the ſides or angles of the field, either to place your Inſtrument or meaſure your lines; therefore, in ſuch caſes, you muſt place your Inſtrument, and meaſure your lines parallel to the ſide thereof, and then your work will be the ſame as if you meaſured the hedge it ſelfe.

Note alſo, that in thus going about a field, you may much help your ſelfe by the Needle, for looke what degree of the Card the needle cuts at one ſtation, if you remove your Inſtrument to the next ſtation, and with your back-ſights look to the mark where your Inſtrument laſt ſtood, you ſhall finde the Needle to cut the ſame degree again, which will give you no ſmall ſatisfaction in the proſecution of your work.

Surveying Conferences

By F. W. WELCH

PROFESSOR OF CIVIL ENGINEERING, WASHINGTON STATE COLLEGE

THE IDEA of a national conference of teachers of surveying had its inception at the annual meeting of the Society for the Promotion of Engineering Education at Madison, Wis., in June 1936. In presenting before the Civil Engineering Division a paper on "Surveying" written by Prof. John S. Dodds of Iowa State College, Prof. Fuller of that school ended his remarks with several quotations from my paper on "Summer Surveying Camps" previously presented before the society and published in the SPEE Journal.

Inspired by comments in these papers, a few kindred spirits, such as Rice of LaFayette, Coddington of Ohio State, Fuller of Iowa State, Zelner of Minnesota, Brother Leo of Manhattan, Owen of Wisconsin, and I spent the afternoon discussing the status of surveying.

Rainy Lake Conference

From these preliminary discussions at Madison came an invitation from Prof. Dodds to hold a surveying conference, in midsummer 1937, under the auspices of Committee VIII of the SPEE, at Iowa State's Camp Marston on Rainy Lake. Camp Marston is on a small peninsula, extending from the south shore of Rainy Lake, 40 miles by boat from International Falls, Minn. It was a rather primitive type camp—good cabins; oil lamps; the lake your water supply, shaving water, and bathtub. Thirty delegates attended this conference, representing 1 government agency, 2 instrument firms, and 26 colleges ranging from Massachusetts and New York to Arizona and Washington State. Subjects discussed included improvement of surveying instruction, content of courses, instruments, field notes, engineer license laws, aerial surveying, plane coordinates, and summer camps. The conference furnished an unusual opportunity for the representatives of the instrument makers to exchange ideas with the users of their products and resulted in a better understanding of each other's problems.

Evenings were given over to visiting, committee conferences, and campfires. The intimate personal contacts with men of like interests from all over the United States, and the warm friendships formed there, have become known as the "Spirit of Rainy Lake."

It was found from the discussions that the methods of teaching in vogue at Washington State College are very closely in accord with those in Massachusetts, Iowa, and Arizona.

Regional and Other Conferences

In 1938–39, regional conferences were held at Rensselaer, University of Louisville, Missouri School of Mines, and Georgia School of Technology, culminating in a second National Surveying Conference at Camp Case, Ohio, in August 1940. This conference was held at the summer surveying camp of the Case School of Applied Science in the Mohican State Park near Loudonville,

From a paper presented at meeting of Northwestern Section, American Society for Engineering Education, Pullman, Wash., May 10, 1947.

Ohio. Highlights of this conference were papers on precision control surveys, photogrammetry, State Coordinate Systems, and the legal aspects of surveying.

In 1940 and 1944 state conferences to discuss control surveys and a state-wide coordinate system for Texas were held at Texas Agricultural and Mechanical College. These conferences were sponsored by the Civil Engineering Department of the College, the State Highway Department, and the General Land Office of Texas.

Then, early in 1941, the American Congress on Surveying and Mapping was formed in Washington, D. C., to unite in one society educators, practitioners, instrument manufacturers, and government survey agencies for the dissemination of surveying and mapping information and for the exchange of ideas for the advancement of the profession. The organization of this new society was jointly sponsored by the Division of Surveying and Mapping, American Society of Civil Engineers; Committee VIII, American Society for Engineering Educacation; American Society of Photogrammetry; and the National Geographic Society.

The programs at the two national and four regional conferences attracted 490 persons, representing numerous schools, commercial organizations, and government agencies. A total of 103 prepared papers were presented on such subjects as teaching and instructional problems, general surveying practice, state-wide and local coordinates, and photogrammetry. These figures do not include 17 formal papers on the use of aerial photographs and the Texas State Coordinate Systems presented at the Texas meetings.

Purposes of Conferences

To state briefly the purposes of these conferences, I quote from a paper on "Surveying and Mapping Conferences" presented at the annual meeting of this society at Berkeley in 1940 by George H. Harding, now Research Professor of Civil Engineering at Ohio State, and the late H. M. Dibert of the Gurley Company, for many years Secretary of Committee VIII. It reads as follows:

1. To cause the teachers of surveying courses to self-examine critically the course content and methods of teaching.
2. To cause the teachers of surveying to improve and "streamline" their surveying courses eliminating non-essentials and adding new material made necessary by future widespread use of precision surveying for control purposes, state-wide coordinates, and photogrammetry.
3. To create a new "esprit de corps" among the surveying teachers, an aroused interest in their subjects, with general recognition of recent important developments and future potentialities.
4. By means of these conferences to "get acquainted" with others of like interests, exchange ideas and suggestions, and consider as a group the problems confronting us rather than as individuals.
5. To set up after discussion and due consideration certain minimum standards.
6. To include in these meetings and discussions not only the members of the teaching profession, but outstanding national authorities on surveying, representatives of governmental surveying and mapping agencies, and practicing engineers, as well as the manufacturers of surveying equipment.

Although surveying and mapping form the basic ground work for the design of all engineering structures as well as the major source of employment for

present-day civil graduates, the teaching of this subject has too often been delegated to the least experienced members of the faculty with the idea that it is just a stepping stone to more interesting subjects. In other words, surveying has been considered a dead subject.

Plan for State Conferences

Suddenly what a revolution! To meet increasing demands for more accurate surveys needed for engineering projects and national defense, the surveying profession developed new and more efficient methods, such as the State Plane Coordinate Systems, based on the Lambert conformal conic projection and the transverse Mercator projection, and control surveys made with theodolites reading to tenths of a second, and elevations adjusted to U. S. Coast and Geodetic Survey and U. S. Geological Survey bench marks. Ordinary mathematics through calculus became just a stepping stone. A surveyor needed courses in differential equations and least squares for the adjustment of his observations.

Photogrammetry advanced amazingly in scope, producing maps on scales varying from 1 inch equals 100 feet to 1 inch equals nearly 4 miles with contour intervals from 2 feet to 1000 feet. Shoran, Radar, and other electronic devices for determining distances are being adapted to various survey uses. These are but a few of the many developments that are today's challenge and opportunity to educators.

A movement is now under way to organize one or more yearly state-wide conferences on these subjects in order to acquaint practicing engineers and surveyors with the latest developments in the science. By next year it is hoped a surveying and mapping conference can be initiated in each state. One such conference has already been held at Georgia School of Technology. The plan is jointly sponsored by Committee VIII of the Society's Civil Engineering Section, American Congress on Surveying and Mapping, and American Society of Photogrammetry.

These conferences hold promise not alone of revitalizing surveying instruction in our colleges but also of providing channels for the dissemination of the latest surveying and mapping techniques.

❦ ❦ ❦

Effective Collective Action

California's amplified registration law that was passed recently was rewritten during the process of legislative action until it conformed to ideas of California's civil engineers as to what would best protect the professional standing and prestige of engineers as built up in the many years during which only civil engineers have been registered in that state. This desire to protect and further professional standing should be commended as should also the effective way in which the civil engineers brought their idea to the attention of the legislators. Their endeavor bore weight because it represented the unified efforts of all civil engineering organizations in the state without dissension.

Similar cooperation on a national scale resulted in success in getting Congress to write into the Taft-Hartley Act provisions concerning professional men. Because of the large number of engineering organizations, such close cooperation was difficult to obtain in the past.—*Engineering News-Record,* July 24, 1947.

Application of Special Instruments in Surveying

By PAUL MORRIS

SENIOR CIVIL ENGINEER, TENNESSEE VALLEY AUTHORITY

ONE of the primary interests of the Tennessee Valley Authority has been in "down to earth" surveys. A few of the instruments more commonly used by field survey parties of the Maps and Surveys Division of TVA are discussed in this paper. Some of these were made in the Division's instrument repair shop to solve special problems encountered in our survey work comprising assignments which range from the roughest type of field reconnaissance to some of the most difficult and precise surveys.

Precise Subsidence and Displacement Measurements

A part of the Division's activities are definitely of a research nature, requiring special equipment not found in the instrument maker's catalogues, as well as a degree of precision not often needed in surveying. One such job involved the measurement of regional settlement, resulting from the construction of a large dam and the sectional displacement within the dam caused by the pressure of impounded water. This "regional" settlement survey was accomplished by conventional precise leveling methods before and after construction and impoundage. The levels, however, were run eight times through a series of bench marks set in bedrock at half-mile intervals for a distance of about 6 miles below the dam.

For precise alignment measurements, 40 permanent marks placed slightly below the surface of the concrete and protected by a removable cap were set along the top of the dam in a straight line about 50 feet apart. Alignment precision was obtained by using the "optical" method, all observations being made with floodlights at night to cut down refraction. Specially-designed targets for the job were made. (*See* fig. 1.) A stationary target was set over a permanently monumented point at one end of the dam. A Wild theodolite, with 28-diameter magnification, was then set up over a similar station at the other end of the dam. One of the advantages of using the theodolite in this type of work is that it is equipped with two closely-spaced vertical sighting lines etched in a glass diaphragm so that the vertical target is centered between two lines instead of being partially obscured by the usual single line or "wire" of the ordinary transit. Both the target and theodolite are mounted on low rigid steel tripods about 24 inches above the monumented stations.

The 40 precise alignment marks were pricked into recessed bronze plates set into the concrete pavement on top of the dam by using the specially designed movable target. This target consisted of a telescope mounted vertically on a stable metal frame with an accurate vertical sighting line formed by contrasting colors on the telescope barrel and framework. After the frame is set firmly in place over a plate, the telescope is brought to true vertical position by means of three plate screws and two plate levels. It can then be moved laterally across the line of sight by a slow-motion screw. After the sighting line of the target has been brought into position by directions from the theodolite observer, a reading is taken through the telescope on an accurate paper scale which is firmly glued to the

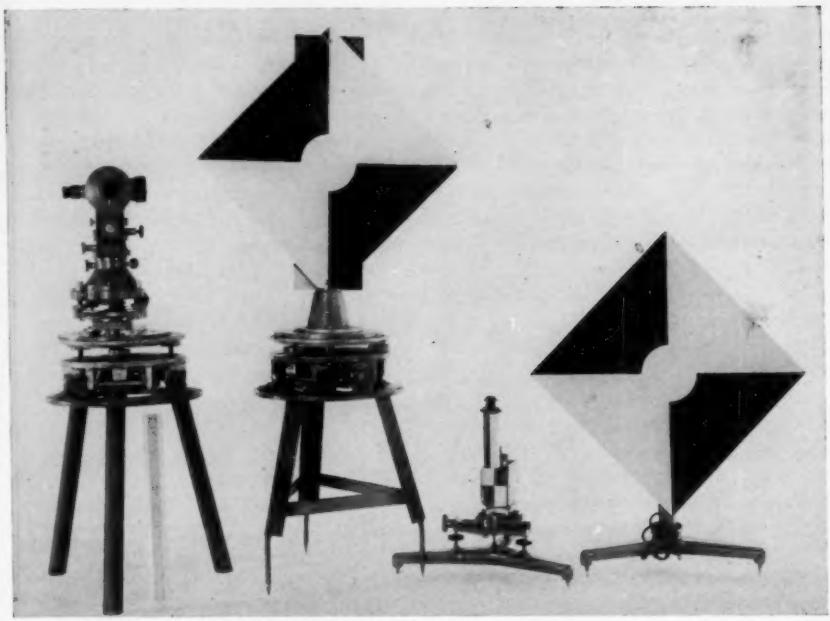


FIGURE 1.—Precise alignment equipment for point setting on dams to measure lateral movement. Reading left to right: (1) theodolite on transverse base (interchangeable as target base); (2) demountable long-sight target (on base interchangeable for theodolite); (3) close-sight movable target and telescope for point settings; and (4) stationary long-sight target.

recessed bronze plate. Altogether, 40 direct and inverted telescope pointings were made and 40 readings were taken on the paper scale in locating each marker point. Finally, the 40 readings were averaged and the average value was pricked through the paper scale into the bronze plate. A total of 1,600 pointings were required on this particular job to establish originally the precise location of the line.

The theodolite and stationary target were carefully centered over their station marks by means of auxiliary transits set on line approximately 15 feet from the stations. In making each pointing, the theodolite was aligned by a sight at the distant stationary target. Walkie-talkie was used for communication between the theodolite observer and the target operator.

The scales used in measuring target positions are printed on moisture-proof paper and graduated to 0.1 millimeter. The position of the movable target is read and recorded to the nearest 0.1 millimeter. Ten pointings were made on each of four runs, two runs being made with the theodolite telescope direct and two with the telescope inverted. Five pointings of each run of 10 were made by moving the target to the line from the right and 5 from the left. After the most probable location of the true line had been determined by averaging all of the 40 scale readings, a fine needle punch was used to prick the point through the paper scale

and into the bronze plate at the exact adopted value. A high-powered magnifying glass was used to place the point of the needle punch accurately for marking the position.

The largest probable error of the alignment at any point established by this method is ± 0.002 foot and the average of the probable errors at all marks is estimated to be ± 0.001 foot. After all marks had been punched, a single check run was made over the line. Several reruns were made at different reservoir stages, thus determining accurately the direction and amount of movement in the structure. By using an accurately graduated scale under a magnifying glass the displacement is measured directly on the bronze plate.

Boundary and Contour Marking by Spray Painting

Leaving marks or other means of identifying his lines has always been one of the problems with which the surveyor is concerned. Hacking trees—the traditional method—oftentimes proved unsatisfactory, so the paint brush became a part of his equipment. Before the spray painting method was evolved survey parties had painted with brushes 3,500 miles of shoreline or "pool contour" on five reservoir projects. The practice is to mark with a 4-inch painted white band the contour below which trees, brush, buildings, etc., are to be removed. The band is painted on such objects as trees, stumps, fence posts, telephone and telegraph poles, boulders and outcropping rock, buildings, and other prominent objects, the top of the band being at the contour elevation. Usually this is one of the first operations in reservoir work, and therefore must be of sufficient permanence to last several years.

Brush painting was found to have several disadvantages. Before a good paintline could be made on trees the bark had to be smoothed. Thus, the time required for bark preparation work and the painting process became the governing factors in the speed of the survey parties. Also, it was found that after the bark was smoothed, oftentimes sap penetration so discolored the paintline that a great deal of repainting was necessary.

Thus the desire for economy mothered the invention of spray painting which has become the standard method of marking pool contours—producing a much better job at less expense. The equipment consists of a nonbleeder presser feed spray gun, equipped with an adjustable nozzle and attached to a mason jar, a specially designed two-compartment pressure tank, a 5-foot length of hose, a thumb release for starting and stopping the flow, and a safety pop valve attached at the connection between the hose and the spray gun.

Pressure is generated by carbon dioxide formed when dry ice changes from a solid to a gas. When the upper chamber is loaded with from 6 to 10 pounds of dry ice, sufficient pressure is generated without the use of an accelerant, but when ice melts to a weight below 6 pounds the addition of a catalytic agent is necessary. Water will accelerate the action, but it has a tendency to freeze up the safety valve, thus creating the possibility of an explosion. Kerosene is the best agent as it has a much lower freezing temperature. About 1 pint of kerosene is placed in the bottom compartment of the tank and when additional pressure is needed the tank is tilted over on its side, causing the kerosene to come in contact with the dry ice, thus generating sufficient pressure for constant painting. Returning the tank to an upright position retards the process, so it is possible to obtain just the amount of pressure needed without waste of dry ice or paint.

Spray painting produces a better paint mark, as the paint penetrates into the cracks and crevices of the tree bark, and does not require bark preparation. The paint lasts longer; there is no sap discoloration of the painted line; and the process is much faster than brush painting. In addition, it requires less paint than brush painting, the saving in paint thus paying for the required dry ice. About 8 pounds of dry ice is used per day in contour marking work. The same method is also employed, in preference to blazing, for marking reservation boundaries through wooded areas.

Use of Elevated Survey Instruments

On topographic surveys considerable advantage has been gained by elevating instruments above the tops of corn and other crops in order to avoid cutting lines for random spot shots. This has proven especially adaptable to planetable work in connection with both large-scale detail site topography and small-scale mapping. Three methods have been used, each of which has its advantage. For site topography it is preferable to extend the length of the tripod legs by bolting on extensions. The planetable operator then works from a platform, which has been built in sections from very light materials and can be taken apart, carried to a new station, and bolted together again in a few minutes. This method has the advantage of making it possible to set up accurately over a control station and orient the table by needle, or by backsight. In the other two methods the instrument is mounted on a truck. The planetable may be set up inside a covered pick-up truck (the truck body being stabilized by placing jacks under the frame) or on a securely braced platform on top of a truck. The principal disadvantages of these methods are the inability to orient by the needle because of local attraction and to set the instrument exactly over ground stations. However, on small-scale work these disadvantages are not serious and are outweighed by the advantages gained when the area to be mapped is in tall crops.

Radio Intercommunication

The walkie-talkie and handy-talkie, developed during World War II for the Army, are now playing important roles in surveying. This equipment is used on hydrographic surveys in boat-to-shore communication, in triangulation work, in precise deflection surveys, and in barometric leveling. The range of present equipment is about 4 or 5 miles; however, the latest models are reported to have a 10- or 15-mile range which should open many new fields of use.

Precision Altimeters

Precision altimeters, imputed to be accurate enough to measure elevations to the nearest foot, are being given rigid ground tests in the hope that careful use of them, together with the ability to communicate by walkie-talkie with a base station instrument at a bench mark of known elevation, will make it possible to establish supplemental vertical control of sufficient accuracy for large-contour-interval topographic mapping by stereophotogrammetric processes and also for map-accuracy tests of the resulting product. Tests to date along this line are promising. With the walkie-talkie, it is possible to apply corrections for atmospheric pressure and temperature changes immediately after they are observed at the base station.

The Stereoscope

In recent years, considerable attention has been given to the development of mapping processes based on the stereoscopic principle.

A simple inexpensive stereoscope is the pocket magnifying type. After a little practice with this device a person with average vision is able to draw fair "form-line contours" on aerial photographs, select preliminary route locations, and obtain a considerable amount of valuable information on the terrain. As a result of such office work field survey costs are substantially lowered.

Before going on the ground TVA engineers make a practice of studying the area under a stereoscope. Aerial photographs are also used as planetable sheets in making many types of topographic surveys. When sufficient elevations have been established on the picture the topographer then views it under the stereoscope with the overlapping adjacent picture and sketches in the contours.

The engineer or draftsman experienced in the use of the stereoscope is also able to identify certain row crops, types of trees, and numerous other details. Frequently, a line of large trees left along a property boundary in a wooded area stands out better and is more easily identified under the stereoscope than on the ground. A pocket stereoscope and a set of contact aerial photographs covering a particular area of interest is, therefore, the best investment an engineer can make.

Reciprocal Vertical Angle Taping Bucks

In all of the more precise control traverse surveys, distances are determined by slope measurements which later are converted mathematically rather than by the use of the more familiar horizontal chaining methods. In areas of considerable relief, on the most precise surveys, the angle of slope is determined by measuring with a Wye or Dumpy level the difference in elevation between the bucks supporting the ends of the tape. In areas of low relief where the slope, for example, seldom exceeds 3 or 4 degrees, and for closures approaching 1 : 10,000, a device was developed for reading reciprocal angles from the bucks supporting the two ends of the tape. (*See* fig. 2.) Most satisfactory results were obtained and, in some instances, the methods not only speeded

Figure 2.—Head taping buck of vertical-angle bucks used in traverse work over rugged terrain.

up the work but also proved more economical by eliminating the need for a level party. Normally, three bucks are used while taping and the rear buck is not moved until the measurement has been carried forward to the next point ahead.

Sundial Direction Instrument

The invention of the sundial as an instrument for indicating the time of day is credited to the ancient Asiatics. The magnetic compass probably is a later discovery, although it is certain that the ancients did have some direction instruments. The first sundial direction instrument was made from aluminum kitchen equipment. A close relative to the first direction instrument developed by the ancients, it is a "horse and buggy" in an aviation age. While the sundial principle is now being used in checking radio direction signals in aviation, this instrument was used by the TVA in making county maps drafted at a scale of 1 inch equals 1 mile long before the use of aerial photographic coverage was common practice. Actually, it is an outgrowth of some of our earlier experience in obtaining direction in survey work by sun shadows. (*See* fig. 3.)

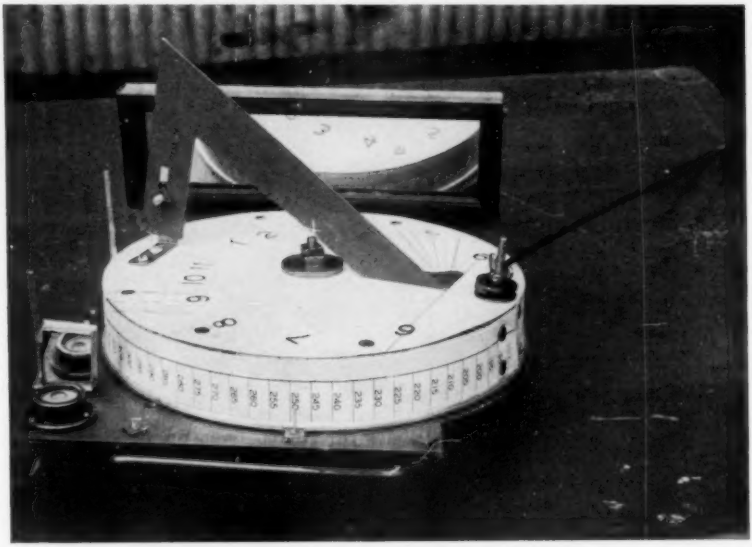


Figure 3.—Early model of a sundial direction instrument. Pin indicates an azimuth of 249 degrees.

In field-checking county maps after the first stages of compilation have been completed, it is often very difficult to orient the map to the winding roads. Thus some parties began to rely on sun shadows for orientation. The gnomon of the sundial must be oriented in a North-South direction to cast a shadow on sun time. By reversing the process, that is, by revolving the sundial until the gnomon casts a shadow on sun time, the gnomon is oriented North-South. It is then a simple matter to measure the azimuth of any given course from the oriented sundial.

The first model of the sundial direction instrument, which was homemade, was constructed to give accuracy to the nearest degree, estimated from the 5-degree divisions along the drum. The instrument has been used mounted on the hood of a car directly in front of the driver and equipped with remote controls for leveling and orientation, making it unnecessary for the operator to get out of the car. Of course during cloudy weather it did not replace the magnetic compass. Also, insofar as its original use is concerned, it was no longer needed when aerial photographs became available. However, it can be used to advantage in areas not covered by photography.

Plant Lay-out Templates

PROVIDING PERMANENT FACSIMILES, accurately scaled, of machines and equipment, new acrylic templates for plant layout are made from sheet-Plexiglas, one surface of which is coated with a photosensitive emulsion. Scaled drawings of machinery and equipment are reproduced as negatives on this emulsion. Then, by carefully cutting the plastics around the outline of the reproduced drawings, accurately scaled templates are produced, on whose under-sides are diagrams in negative of the machines which they represent.

These templates are used in conjunction with a thin, transparent plastics mat which is ruled off into quarter-inch squares (each square representing one square foot). On this mat the outlines of the plant area, along with locations of conduits, traffic aisles, tool cribs, material bins, and so on, are drawn with grease pencil.

To make a blue-print of a proposed or final lay-out, a smooth magnetic-metal sheet is overlaid with a special printing paper. On top of this is placed the mat representing the plant area. The templates of machines and equipment are then set on the mat. The attraction for the metal plate of small, circular Alnico permanent magnets fixed to each template, hold the template securely in any desired position.

According to the over-all size of the lay-out one or more quad-lamps with reflectors are used to expose the paper. Development of the pattern is accomplished in about three minutes over an ammonia vaporizer. The resulting print shows, in blue on white, a positive reproduction of each piece of machinery and of the other floor-plan details, superimposed upon the scaled floor area.—*Scientific American,* December 1947.

Scientists Probe Under Atlantic

MANY SECRETS of the earth's past, and possibly of its future, may be revealed by a study now going forward of the unexplored bottom of the Atlantic Ocean roughly halfway between America and Europe. An effort is being made to measure, by means of sound waves, the heights of undersea peaks and the depth of the "floor" in a 50,000 square-mile area about equidistant from Bermuda and the Azores. In addition, samples will be unearthed of primeval silt, whose layers, like the rings of trees, furnish a record of age.

The expedition, aboard the ship *Atlantis,* is jointly sponsored by Columbia University, the National Geographic Society, and the Woods Hole Oceanographic Institution. The "echo-sounding," by means of which a graph will be constructed of a portion of the area known as the Mid-Atlantic Ridge, a chain of mountains a mile or more below the surface, consists in measuring the time required for a sound wave produced aboard the ship and then reflected back from the ocean floor, from peaks and shoulders, or even from rocks beneath the sediment, to make the round trip. The scientists will lower steel tubes 10 to 15 feet long in order to trap a cross-section of the ooze containing the residue of minute seaweed and the skeletons of microscopic animals. It may have required a thousand years, they say, to build up a half-inch layer of sediment. Photographs of the undersea scene will be taken with a specially constructed camera.—*Think,* August 1947.

East Bay Triangulation Net

By W. R. McLEAN* *and* S. P. HAND†

THE East Bay Municipal Utility District, with the cities of Oakland, Alameda, Berkeley, Richmond, El Cerrito, Emeryville, Piedmont, San Leandro, and Contra Costa and Alameda counties of California, are co-operating in a joint project with the United States Coast and Geodetic Survey to establish a system of precise geodetic control and coordinates.

In 1932, after the East Bay Municipal Utility District had acquired the various properties of the East Bay Water Company, the District established a fourth-order triangulation scheme with plane coordinates for the purpose of mapping the lands and watershed areas. The existing Coast and Geodetic Survey triangulation network was used as the base, with station GRIZZLY 1932 as the origin of coordinates. GRIZZLY 1932 was set as 50,000 North and 50,000 East on the coordinate system. Approximately 25 stations were established at that time and tied to the Coast and Geodetic Survey stations along the bay. Most of the stations established at that time were located along the Oakland and Berkeley hills, with a few stations in the Orinda and Lafayette areas. In recent years this triangulation scheme has been expanded to more than 100 stations, 30 of which may be classed as primary, and the remainder as secondary or supplementary. All the work was done with standard transits and day observations, therefore, the accuracy compared only with third- or fourth-order work, or about 1 in 5,000. This scheme has served the purpose of the Utility District very well as it was more accurate than most of the existing cadastral surveys in the area.

Many of the stations were located and used by the U. S. Army during 1942 while mapping this area. In addition, many of the local engineers and surveyors have used the stations for position and bearing. However, the accuracy of the scheme was such that it could not be used to any advantage for city surveys, and a scheme with a high degree of accuracy was needed. Rural areas were being subdivided, land values were rising rapidly, city property was becoming highly developed, and a common coordinate system was needed in the area upon which to base all future surveys.

If each surveyor has his own control points that are not correlated with others, there is confusion. As a city grows and the value of property increases, the need for precise control multiplies. In laying out work covering large areas, such as city streets, subdivisions, and water and sewer lines, errors can be held to a minimum with well-spaced precise control points.

Establishment of the New Survey

On October 8, 1945 a meeting was held of all the city and county engineers. At this meeting a representative of the United States Coast and Geodetic Survey was present, and advised the group that the Survey was eager to co-operate with municipalities on geodetic surveys.

Condensed from *Western Construction News*, March 1947.

* Senior Civil Engineer, East Bay Municipal Utility District, Oakland, Calif.

† Geodetic Engineer, U. S. Coast and Geodetic Survey.

Subsequently on December 13, 1945, L. G. Simmons, principal geodetic engineer of the Survey, arrived in the Bay area and began the reconnaissance survey. He completed his survey and presented the results to the group on January 24, 1946. The group of engineers were in favor of proceeding with the project, and the Director of the Coast and Geodetic Survey in Washington, D. C. was requested to prepare an estimate of cost for the work outlined in the Simmons report. The part of the cost to be paid by the local group was estimated at $60,200. The Survey agreed to furnish the skilled personnel, instruments, steel towers, monuments, etc., and to compute and publish all data. The Survey's share is approximately equal to the contribution from the local group. The estimated time for doing the field work was 5 months. Because of weather conditions it was essential that the work be started in the early fall and completed during the winter as this period was thought to be the most favorable for night observations.

In the Coast Survey's report, it was estimated that approximately 120 triangulation stations would be required in the network with about 100 first-order traverse stations in the city of Alameda. To proportion the cost of the project among 12 agencies, in order for each to pay a fair share, was difficult. The needs of each city were different and the stations were more numerous in the cities than

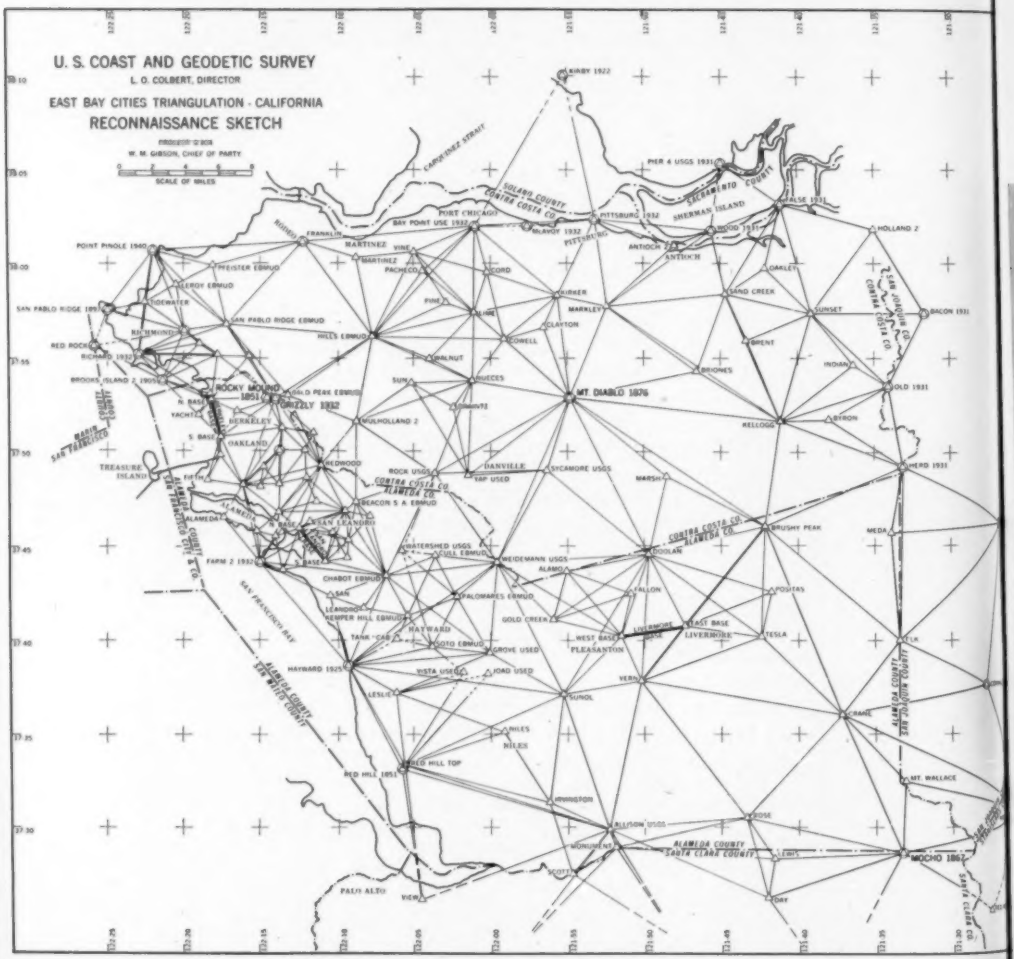


FIGURE 1.—Observation party ready for work. Tent protects both instrument and observers from wind and weather. Signal light shown in foreground.

FIGURE 2.—Setting up theodolite preparatory to night observations in the East Bay area triangulation survey. Most stations are on prominent hilltops.

in the counties, where large areas are undeveloped. The city of Alameda, being entirely flat, could not be adequately served by a triangulation scheme; and it was decided to establish about 30 miles of first-order traverse throughout the city, tied to the triangulation scheme with five stations.

The cost was finally computed on a monument basis, each agency to pay approximately according to the number of monuments established and the value within its boundaries. On this basis, the East Bay Municipal Utility District, the cities of Alameda and Oakland, and Contra Costa and Alameda counties each contributed about $10,000 as their share, with the remainder contributed by Richmond, Berkeley, Piedmont, Emeryville, El Cerrito, and San Leandro in the amount of $1,000 each.

The Coast and Geodetic Survey may not accept funds from any outside agency,* therefore it became a problem to designate some agency to sponsor the project in order to obtain the necessary personnel and disburse the funds. Finally, the group requested that the Utility District sponsor the project. J. S. Longwell, chief engineer and general manager of the District, willingly agreed to present this request to his board of directors, and they in turn consented to sponsor the project. W. R. McLean was appointed chairman to co-ordinate the work between the sponsor and the Coast and Geodetic Survey.

Many individual cities in the United States, such as New York, Hartford, Rochester, Richmond, Cincinnati, Atlanta, Cleveland, Minneapolis, Pittsburgh, and others, have established triangulation schemes for control of city surveys, but this is the first time that a group of cities and counties have co-operated on a joint project of such magnitude.

Area of the Survey

Essentially, the general over-all scheme covers an area bounded on three sides by established triangulation with the southeast corner of the area controlled by the old station MOCHO. The center of the area is controlled by ties to station MT. DIABLO. This station and ROCKY MOUND, established by the Survey in 1851 and 1876, respectively, are the oldest stations in the scheme.

The total area to be controlled is approximately 1,500 square miles, of which only about 100 square miles might be considered metropolitan area. The total number of stations required, including the established stations that must be occupied, is 130. (This does not include the traverse stations in the city of Alameda.) Approximately 40 stations are located in the metropolitan area from Richmond to San Leandro, 50 stations are in the areas of most importance and development in the two counties, and the remainder are existing stations in the area.

The major portion of the area to be controlled under the program is of a low mountainous type ranging from sea level to a maximum elevation of nearly 4,000 feet. The area is fairly free from timber, making the use of steel towers unnecessary except on a small number of stations.

The problem of length control is difficult on a project of this nature, in that there exist so many established lines having varying degrees of accuracy. The

* Recent legislation passed by the Congress of the United States permits the Coast and Geodetic Survey to accept funds from other than federal sources for the accomplishment of precise surveys.—Ed.

various cities in the metropolitan area desire the highest degree of accuracy, probably of the order of 1 part in 100,000. To obtain this accuracy it has been found necessary to establish three base lines within the scheme—one in the Livermore Valley and two in the metropolitan area.

In the city of Alameda, the general plan includes three traverses lengthwise within the city. Two lines are extended northward to permit an east and west traverse to be run across to form a loop. The five triangulation stations established in Alameda are distributed so as to properly control the traverse area.

Establishing Survey Points

There are two methods of establishing these control points: triangulation and traverse. Traverse is better suited to flat terrain, and consists in directly measuring the distance and direction from one point to the next adjacent one; while triangulation is better adapted to rough terrain, where visibility is more easily obtained from one point to a distant one, and where measurement along the ground is impractical.

Each station is marked by a bronze disk, either set in a concrete post embedded in the ground, or cemented in a drill hole in rock. The name of the station and the year it is established are stamped on the disk. Wherever possible, another mark is set directly beneath the station mark, and about 4 feet deep, to preserve the point should the surface mark be destroyed. Two reference marks, also bronze disks, are established at each station to aid in the recovery of the mark. Distances and directions to these are measured and published.

An azimuth mark is set for each station, at some distance away, provided the station is not conveniently intervisible with another station. The azimuth of this mark as measured at the station is determined and published to supply the local engineer with a starting bearing. These marks are valuable to the community in which they are located, and the public should try to preserve them. However, one of the valuable features of triangulation control is that, although a mark may be entirely obliterated, it can be replaced in its exact position. Indeed if any number of marks are destroyed, they can be replaced, although at considerable expense, provided they have been connected to the triangulation network of the Coast and Geodetic Survey.

Field Methods

The field methods of the Coast and Geodetic Survey are being used, with some refinements to obtain an accuracy of 1 part in 100,000. This means that for each mile the error should not exceed 0.6 inch. A precise theodolite, with two micrometers reading to 1 second, is used to measure the angles. Each angle is measured with 16 positions of the circle, or actually 32 times; the average of these is then taken out to 0.01 second. Triangle closures are held to a maximum of 3 seconds with an average closure of not to exceed 1 second. When there are two or more ways to compute the length of a single line, the check between these computed lengths is held to a high degree of rigidity.

The observations are made on lights at night, to avoid refraction caused by the heat of the day. The lights are especially built for this use, enclosed in box frames, with special reflectors and bulbs designed to permit focusing. Instruments and lights are accurately centered over the station marks. The accuracy of the triangulation is checked by connecting to the three base lines to be established. These bases will be measured with invar tapes.

The triangulation party consists of 32 men and is divided as follows: three observing units, two building crews, light-keepers, computers, and reconnaissance men.

The traverse stations in Alameda are marked with bronze traverse disks set in precast concrete posts. These are embedded under the sidewalk pavement, access being provided by small cast iron frames with lids. The marks are placed at street intersections, approximately 1,000 feet apart, to provide, where possible, visibility in four directions. Measurement of angles will be made with a small theodolite of high precision, and all distances will be measured with invar tapes that have been standardized by the National Bureau of Standards. The tapes will be stretched with a set tension, and temperature readings will be taken so that corrections for expansion can be made. It is expected that the traverse, like the triangulation, will be accurate to 1 part in 100,000.

Progress of Survey

A reconnaissance party began operations during September 1946. Work on the project was officially started October 1, 1946, and on March 1, 1947, the project was 85 percent complete. All reconnaissance is complete, and all the triangulation and traverse stations have been constructed. Observations are complete on approximately 75 of the stations. Measurement of the traverses in the city of Alameda is now being undertaken.

All field computations are being maintained to keep pace with the field observations. All triangles are checked for closure and the geodetic position computed for each station. These are preliminary only and serve as a check on the accuracy of the field work. Upon completion, the results of the survey will be forwarded to Washington where the measurements will be adjusted and the accurate position of each station computed. The final data will be published by the Coast and Geodetic Survey and will give the geodetic and plane coordinates for each station. The latter are based on the Lambert conformal projection as established for Zone 3 of the State of California.

A great deal of effort is being devoted to this work by the members of the Survey and engineers in the co-operating groups, and it is hoped that it may serve as the basis of similar work in many other parts of the United States.

WASHINGTON OFFICE COMMENTS

The field work for the East Bay Triangulation net was completed about July 1, 1947. The invar tapes that had been used in the base measurements were then restandardized at the National Bureau of Standards. After the field records and notes were received in the Washington Office, the computations and adjustments were started.

The triangulation at the western edge of the project over the cities of Berkeley, Oakland, and Alameda was adjusted as a unit without regard to previously adjusted data. This method permits a free adjustment without any distortion taking place for the purpose of satisfying extraneous conditions.

In this concentrated network the average triangle closure was 1″.00 with a maximum closure of 2″.92. The adjustment of this part of the project has been completed with the results giving an average correction to a direction of 0″.41 and a maximum correction of 1″.46. The maximum correction to an angle in a triangle is 2″.51. These statistics show that the network over the cities is of a high degree of first-order accuracy.

The adjustment of the remaining triangulation in the network is in progress and will be completed early in 1948. This part of the project is to be adjusted to the previously adjusted data in that area and to the values derived from the adjustment over the cities at the western edge of the new scheme.

The final adjusted data with descriptions of the stations will be published by the Coast and Geodetic Survey and be made available for general distribution.

First "Sofar" Station

THE FIRST "Sofar" receiving station in the new Navy long-range, underwater sound system for locating air and ship survivors at sea, is ready for operation. This station, located at Monterey, Calif., recently heard and recorded the sound of a bomb exploding under water 2,300 miles away.

This Monterey station is the first of four which will be used to cover the Pacific. A second will be located at Point Arena, northwest of San Francisco; the other two on separated islands in the Hawaiian group.

Sofar is a war-developed system coming as a by-product of submarine-detection studies carried out under the leadership of Dr. Maurice Ewing of Columbia University for the Navy at Woods Hole Oceanographic Institution in Massachusetts. In tests made in the Atlantic over a year ago, sound was picked up 3,100 miles from its source. It is expected that this range will be doubled with improved equipment.

In the system, a bomb designed as standard equipment on lifeboats is dropped overboard by the survivors. It is triggered to be exploded by the water pressure when it has descended about a half mile. It is then in a layer of water, from some 2,000 to 6,000 feet below the surface which, somewhat like a speaking tube, confines the sound waves within itself and transmits them for long distances.

At the receiving station, recording equipment is connected by submarine cables to nearby hydrophones which are set deep in the water to receive the sound waves. These hydrophones pick up the underwater sound waves much as the ordinary telephone picks up the air sound waves from the human voice.

One Sofar receiving station alone can not determine the position of the exploded bomb. Two or more are required. The sound waves, which travel at about 4,800 feet per second, will reach them at different times, unless they happen to be at the same distance from the sound source. In operation, each station reports by wire or radio to a central station immediately upon receiving a sound signal, giving the exact time received.

From the differences in time of receipt the location of the bomb explosion is rapidly computed. Then rescue crews are ordered on their way. Tests show that the location is accurate to within a mile or so of the correct position.—*Science News Letter*, July 12, 1947.

Navigability

By AARON L. SHALOWITZ

PRINCIPAL CARTOGRAPHIC ENGINEER, U. S. COAST AND GEODETIC SURVEY

EDITOR'S NOTE.—This article is reprinted at this time because of the current interest in H. R. 2973, introduced in the House of Representatives on April 7, 1947. The bill, which amends the Federal Power Act, contains, among other things, the following definition of navigable waters, which is of interest as another possible development in the law of navigability:

"Navigable waters" means those parts of streams or other bodies of water over which Congress has jurisdiction under its authority to regulate commerce with foreign nations and among the several States, and which at the time of the inquiry are generally and commonly used for commerce of a substantial character consisting of the transportation of persons or property in interstate or foreign commerce, or have a reasonable probability of being so used either in their natural condition or by then proposed improvements, the estimated cost of which is reasonably commensurate with the commercial benefits to be derived therefrom, including therein all interrupting falls, shallows, or rapids compelling land carriage, together with the parts of any streams which have been authorized by Congress for improvement by the United States for the purpose of furthering navigation in interstate commerce.

A DECISION of more than passing interest to both the engineering and legal professions was recently delivered by the Supreme Court of the United States in the case of U. S. vs. Appalachian Electric Power Company. (311 U. S. 377.) The case relates to the construction of a hydroelectric dam by the Power Company on the New River just above Radford, Va., and involves the scope of the federal commerce power in relation to conditions in licenses required by the Federal Power Commission for the construction of such dams in navigable waters of the United States. The determination of the case rested on the question whether the New River, a tributary of the Kanawha and Ohio Rivers, is or is not a navigable water of the United States. The Supreme Court answered this in the affirmative and thereby reversed the concurrent findings of both the District Court and the Circuit Court of Appeals.

The interest in this case, insofar as this discussion is concerned, lies not so much in the particular rights adjudicated, as in the new concept of navigability which the high court enunciated and the far-reaching possibilities inherent in it. To comprehend the full significance of this new doctrine, it must be appraised against a background of juridical principles developed in this country through a century and a half of constitutional government.

THE REGULATORY POWER OF CONGRESS OVER NAVIGABLE WATERS

Article I, Section 8 of the Constitution of the United States provides: "The Congress shall have power to regulate commerce with foreign nations, and among the several States, and with the Indian Tribes."

The full import of the grant of authority contained in this clause—known as the Commerce Clause—did not appear for many years after the adoption of the Constitution. Not until the year 1824, by the decision of the Supreme Court in the celebrated case of Gibbons vs. Ogden (9 Wheaton 1; 6 L. ed. 23), was a clear

Reprinted through the courtesy of the *United States Naval Institute Proceedings*, July 1941.

indication given of the extent of the power granted. Chief Justice Marshall there laid down, in general terms, the doctrine that by the Commerce Clause, the Federal Government is granted an exclusive control of commerce between the States. And with this case was initiated a long line of decisions establishing the power of the United States to regulate interstate commerce free from state interference—an authority which has done much to increase the actual power and influence of the National Government and which to the present day is affecting our entire social-political structure.

The case of Gibbons vs. Ogden also established, once and for all, the doctrine that the power to control and protect navigation on navigable interstate rivers and other bodies of water was a necessary incident of the power to regulate commerce, and, therefore, the Court held that a grant by the State of New York to an individual of an exclusive right to navigate its waters had no constitutional validity insofar as interstate or foreign commerce was concerned.

The English Doctrine of Navigability

The next important development in our law of navigability was a jurisdictional one and had the effect of broadening the scope of the admiralty jurisdiction of the federal courts.

Until the year 1851 it was contended and successfully maintained in our courts that the federal admiralty jurisdiction was confined to cases arising upon the high seas and rivers as far as the ebb and flow of the tide extended. This view had for its foundation an erroneous declaration by Chancellor Kent in an early case (Palmer vs. Mulligan, 2 Am. Dec. 270, decided in 1805), in which he stated the common law of England to be that navigable waters were those only in which the tide ebbed and flowed. The eminence of the author and the lack of original authorities led many courts in the early days to follow it. This confusion of navigable waters with tide water long prevailed in this country and had the influence for two generations of excluding the admiralty jurisdiction from our great rivers and inland seas.

It was not until 1851, in the case of The *Genesee Chief* vs. Fitzhugh (12 Howard 443; 13 L. ed. 1058), that the Supreme Court expressly overruled its former decisions and adopted the more liberal principle that the test of navigability is the actual navigable capacity of the waterway and not the extent of the tidal influence. In re-examining the former cases the Court pointed out that the reason for the English rule was that the limit of the tide in all waters of England was at the same time the limit of practicable navigation, and that as there could be no use for an admiralty jurisdiction where there could be no navigation, this test of navigability became the rule, instead of the navigability itself. Such a rule, the Court showed, could have no pertinency to the rivers and lakes of this country because of the broad differences existing between the extent and topography of the British island and that of the American continent. Since many of our rivers could be navigated for a thousand miles above tide water as they could below, it was absurd to adopt as the test of admiralty jurisdiction in this country an artificial rule which was founded on a reason in England but which was wholly inapplicable here.

Test of Navigability

While the decision of The *Genesee Chief* was a jurisdictional one, once the tidal test was jettisoned and the doctrine of that case firmly established in our

jurisprudence, the way was cleared for the courts to define specifically the test of navigability insofar as it related to the regulatory power of Congress under the Commerce Clause. Accordingly, in 1871, the Supreme Court, in the case of The *Daniel Ball* (10 Wallace 557; 19 L. ed. 999), laid down its oft-quoted definition of navigability, namely:

> Those rivers must be regarded as public navigable rivers in law which are navigable in fact when they are used, or are susceptible of being used, in their ordinary condition, as highways for commerce, over which trade and travel are or may be conducted in the customary modes of trade and travel on water.

Until the recent decision was announced (the Appalachian Power Company case), this rule had not been departed from although it had been interpreted and applied in many different factual situations, and as late as 1934 it was even held that an interstate stream is navigable in fact only when it is so used or susceptible of being used in its "natural and ordinary condition" (United States vs. Oregon, 295 U. S. 1; 79 L. ed. 1267).

The New Supreme Court Decision

In the Appalachian Power Company case, the Court reaffirms the doctrine of The *Daniel Ball*, as far as it pertains to the basic concept of navigability, but it holds, in addition, that, while navigability is a factual question, in appraising the evidence of navigability it is erroneous to consider only the natural and ordinary condition of the waterway, but "its availability for navigation must also be considered." Said the Court:

> Natural and ordinary condition refers to volume of water, gradients, and the regularity of the flow. A waterway, otherwise suitable for navigation, is not barred from that classification merely because artificial aids must make the highway suitable for use before commercial navigation may be undertaken. . . . Nor is it necessary that the improvements should be actually completed or even authorized. The power of Congress over commerce is not to be hampered because of the necessity for reasonable improvements to make an interstate waterway available to traffic.

In other words, the Supreme Court now holds that the phrase "susceptible of being used in their ordinary condition," in The *Daniel Ball* definition, should not be construed as eliminating the possibility of determining navigability in the light of the effect of future reasonable improvements. (This was the Government's contention.) And it appears that considerable latitude may be exercised in the application of this doctrine, for although the Army Engineers found that the cost of improving the New River would be "prohibitive," the Court, nevertheless, concluded it was navigable.

Résumé

Summarizing then, the important developments, chronologically, in our law of navigability, we have:

1787—Congress given power to regulate interstate and foreign commerce (Art. 1, Sec. 8, The Constitution of the United States).

1824—Control of navigation declared a necessary incident of the power to regulate commerce (Gibbons vs. Ogden).

1851—Navigable waters declared not to be limited by the flux and reflux of the tide (The *Genesee Chief*).

1871—Navigability defined as waters capable of use in their ordinary condition as highways of commerce (The *Daniel Ball*).

1940—Navigability determined by availability of waterway for navigation through future reasonable improvements (U. S. vs. Appalachian Power Company).

CONCLUSION

From the decisions cited it would appear that in the development of the law of navigability we have indeed moved far from the restrictive doctrine of Chancellor Kent. What the full impact of the latest Supreme Court decision will be or how the courts will construe the enlarged definition of navigability, would be difficult to predict, but a glimpse of its potentialities may be had from the dissenting opinion of Mr. Justice Roberts, and concurred in by Mr. Justice McReynolds, in which he says:

> If this test be adopted, then every creek in every state in the Union which has enough water, when conserved by dams and locks or channeled by wing dams and sluices, to float a boat drawing two feet of water, may be pronounced navigable because, by the expenditure of some enormous sum, such a project would be possible of execution. In other words, Congress can create navigability by determining to improve a non-navigable stream.

* * *

The Joy of Being the Editor

Getting out this paper is no picnic.
If we print jokes people say we are silly;
If we don't, they say we are too serious.
If we stick close by all day
We ought to be out hunting news.
If we go out and try to hustle
We ought to stick closer to the job.
If we don't print contributions
We don't appreciate genius.
If we do print them
The paper is filled with junk.
If we make a change in the other fellow's writeup
We are too critical.
If we don't we are asleep.
If we clip things from other papers
We are too lazy to write ourselves.
If we don't we are stuck on our own stuff.
Now like as not someone will say,
"He stole this from some other paper."

(We did—From the Listening Post.)

Radar Proves Useful Tool in Marine Surveying

By W. H. WILSON
SENIOR ENGINEER, HUMBLE OIL & REFINING COMPANY

CONSIDERABLE publicity has been given during the past year to the potential oil reserves in the continental waters of the United States. A great deal of this interest is centered on the waters of the Gulf of Mexico adjoining the coasts of Louisiana and Texas on the theory that the known producing horizons of these states will be encountered under the waters of the Gulf of Mexico. It is too early to say what the results of this offshore drilling program will be or how far from shore the search will extend. Most of the present activity is now centered in Louisiana where the State Mineral Board has subdivided the Gulf of Mexico water bottoms along the major portion of the coast line and has leased numerous tracts for oil development. Most of these subdivisions extend approximately 30 miles from shore where the depth of the water averages about 60 feet, although in some areas it may be as deep as 150 feet or more.

Geophysical Explorations

In considering the problem of oil development in this offshore area, it will be necessary to conduct geophysical explorations to determine the most likely place to drill. After the well location has been selected, it must be marked by a buoy or a pile, located a certain number of feet from the lease boundaries. If the well produces oil, additional construction may be necessary to treat or to transport the oil. All of this work requires surveying—surveying in a trackless waste of water.

It seems appropriate at this point to make an observation on marine work in general. When operations as familiar and as standardized as oil drilling and geophysical exploration are transferred from their natural habitat on dry land to an area 10, 20, or more miles offshore, where the land not only isn't dry but is 25, 50, or more feet straight down, such operations quickly cease to remain either familiar or standardized. All the usual engineers and experts in the fields of applied science must be called in on the problem, together with a few new ones such as oceanographers and meteorologists. Everything that is done takes more time to perform and is considerably more expensive. Marine surveying is no exception to this general rule.

Geophysical exploration in the Gulf of Mexico has been carried on in Louisiana coastal waters by several oil companies during the past year. The nature of this work demands that the position or location of a large number of points be determined rapidly. Speed is the essence of the work of the engineer engaged in surveying for a geophysical crew. If the crew has to wait while a line is laboriously measured or while a triangulation problem is executed, the lost time becomes alarmingly expensive. Along with the need for speed, a reasonable accuracy must also be attained. However, the accuracy requirements for most geophysical surveying are less severe than for well locations.

In contrast to the geophysical work, the drilling program in the Gulf of Mexico

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is still in its infancy. One well, located 7 miles offshore, is now being drilled by the Magnolia Petroleum Company which has also begun work at another location about 27 miles offshore. Humble Oil & Refining Company has started operations at a location about 7 miles offshore and will soon make another location about 5 miles from shore. Four other tentative well locations have been announced by other companies but work has not been started. The best information on these tentative locations indicates that the distance from shore will be about 3 miles, 7 miles, 12 miles, and 20 miles. In other words, including the Magnolia drilling well, only three well locations have actually been staked. While the surveying problem for well location is not yet acute, it is apparent that the acute stage may soon be reached.

With the foregoing in mind, let us take a look at some of the tools, both old and new, and some of the methods that may be used to solve the surveying problems of marine development. It will be well to maintain an open mind on this matter and give consideration to any new tool or technique that seems to fit the problem. It may also be timely to emphasize that this is not a chronicle of successful achievement of marine surveying, but rather it is an attempt to point out some of the elements of the problem and to discuss a few of the steps that have been taken to meet it. A year from now, or 2 years from now, a much better presentation of this subject can be made.

Triangulation for Marine Surveying

Triangulation from a known base line on shore is a well-established method for locating an offshore point. However, as operations are extended seaward, the practical and economic limits of visibility from shore are quickly reached. In this connection, it may be of interest to refresh our memory as to how fast the curvature of the earth and atmospheric refraction begin to affect the line of sight. Considering both these factors, the differences between an apparent level line and a true level line at a distance of 1 mile is about 0.6 foot; at a distance of 5 miles this has increased to 14.4 feet; at a distance of 10 miles the difference is 57.4 feet; at 20 miles it is about 230 feet; and at a distance of 30 miles the difference has increased to approximately 517 feet. This means that if an observer wishes to see a flag across 10 miles of water, he must elevate the flag more than 58 feet above the surface since at this height the top of the flag will, with average refraction, just be visible. Several more feet will have to be added to the height of the flag to overcome variations in refraction and to provide a good clear view. Of course, the height of the flag can be reduced by raising the observer above the surface level.

Triangulation was the method used to make the Humble Oil & Refining Company well location about 7 miles offshore. Radar was first used to locate a buoy at the approximate well site. Triangulation stations of the U. S. Coast and Geodetic Survey were conveniently available on shore, and the buoy was cut in from two of these stations. It was found that the buoy was located a short distance from the intended location. A single pile was then driven at a new location and rechecked by triangulation from shore. The computations indicated that the pile was within a very few feet of the projected well location.

It is of course possible to extend a triangulation arc offshore for distances greater than 30 miles by following the usual land procedure. This would require erecting towers on shore at existing triangulation stations and building additional towers in the Gulf from which observations could be made. In this manner, a

system of triangles and quadrilaterals could be carried seaward. Probably 12 to 15 miles would be the length of each "step" from shore. This method could be used to locate offshore wells, and it would give results that would meet all accuracy requirements. However, triangulation towers on shore cost money, and when erected in the Gulf of Mexico, they cost lots of money. Triangulation for geophysical exploration is much too slow and cumbersome for the reasons heretofore mentioned.

Radar for Marine Surveying

Perhaps the most promising new tool for the marine surveyor is Radar. Everybody has heard a great deal about its military uses in the recent war; in fact many persons have had personal experience with the wide variety of military uses to which Radar was adapted. The fact that makes Radar of interest to the surveyor is that it can be used to measure both distances and angles. Radar waves are analogous to light waves and travel with the same speed; i.e., at 186,218 miles per second, or about 983 feet in a millionth of a second, usually called a microsecond. Like light waves, Radar waves will be reflected from an object in their path and will bounce back to the point of origin. The principle used in measuring distance with Radar is, therefore, fundamentally simple. Radar waves are transmitted or pulsed toward an object at regular intervals. These waves are reflected back from the object, picked up at the transmitting station, and the time required for a wave to make the round trip is measured. One half of this time interval multiplied by the speed of travel of the wave gives the distance to the object. The Radar set is constructed so that this computation is made automatically and the distance to the object is read directly on a dial.

The angle between two reflecting objects can be measured by successively turning the Radar beam on each object and reading the resulting angle or bearing. However, the Radar set must be specifically designed for this purpose in order to read angles with a sufficient degree of accuracy to be of value as a survey instrument. Only one type Radar is available that can measure angles with an accuracy approaching survey requirements. This is a military unit, called SCR-784, which was designed to control the fire of anti-aircraft batteries. An SCR-784 unit can measure angles with a probable error of one mil. A mil is the angle subtended by a yard at a distance of 1000 yards, and amounts to 3.5 minutes. An SCR-784 unit was used for geophysical surveying and it worked fairly well as long as the distance from shore did not exceed 8 to 10 miles. One serious disadvantage was the large size and unwieldiness of the unit, which was mounted on a trailer and weighed around 25,000 pounds. Anyone familiar with the Louisiana coastline can realize the difficulty encountered in moving this equipment. Other disadvantages of this land-based unit were the need for radio communication from ship to shore and the need for a separate crew, with the attendant supply problems.

With one exception, which will be discussed later, the Radar equipment now available is military equipment designed to meet a particular need of the Army or Navy. Certain of these instruments can measure distance or range with a probable error of $\pm$ 20 yards. This error is a constant error and is independent of the distance measured. An error of 20 yards in measuring a line 10 miles long would have a magnitude of 1 part in 880. It is claimed that some Radar equipment now in use has a range error of only $\pm$ 5 yards or a magnitude of error of 1

part in 3520 in a line 10 miles long. Doubtless this accuracy can be attained under favorable conditions, but it is not certain that it can be obtained at all times. The figures given as to the degree of accuracy of distance and angle represent what is obtainable with present equipment. This is not by any means the ultimate limit of accuracy of Radar in either of these respects. To my knowledge, no Radar equipment has been designed, to date, for the primary purpose of surveying. It is reasonable to expect that when this is done, the accuracy of range and angle measurement will be greatly increased.

Darkness, fog, or rain do not prevent the use of Radar, but Radar does have its limitations. Radar waves travel a straight path from the transmitter to the reflecting object in a manner similar to light waves. An intervening hill, forest, or the hump due to the earth's curvature will obstruct the Radar wave. Therefore, in marine surveying, the length of a single Radar "shot" is controlled by the earth's curvature and refraction, which is the same thing as saying the antenna and target must be elevated. Other factors that affect signal intensity are the distance the Radar wave must travel and the size of the Radar target. The intensity of light varies with the square of the distance, while the intensity of a Radar signal varies as the fourth power of the distance. It follows that for a given distance a large target reflects a stronger signal than a small target.

How Radar Is Used

When a position to be determined lies too far offshore for the Radar to pick up shore targets, two or more intermediate targets can be set, and a system of triangulation carried out the desired distance. There is this difference in triangulation by Radar and triangulation by ordinary land methods. Radar is used to measure the lengths of side of each triangle instead of measuring angles. In marine work this has the considerable advantage of not requiring stable towers or platforms to be constructed in the sea. Existing channel buoys or lighthouses can be used as intermediate points, or if these are not available, temporary buoys supporting Radar targets may be anchored for as long as needed.

This is one of the methods now in use for geophysical surveying. A Mariner's Pathfinder is the Radar equipment used. This equipment has been on the market for about 8 or 9 months, and apparently it has the distinction of being the first postwar Radar to appear on the civilian market. Designed as a navigational aid for all types of shipping, it was necessary to modify the equipment after purchase in order to increase its range accuracy to a $\pm$ 20-yard error. It should be noted that this instrument is primarily designed to measure distance and its angle or bearing accuracy is only $\pm 2°$. The Mariner's Pathfinder unit is installed on the surveyor's boat. Position determinations are made by measuring the distance to two or more targets on shore. Oil derricks make excellent Radar targets, but if these are not available, lighthouses, beacons, or buoys may be used. This method results in a very flexible operation and eliminates the need for any communication since the Radar instrument is located on the boat whose position is desired.

The same equipment is employed in a slightly different manner by using a target boat which is equipped with a Radar target, the centerline of which is elevated about 300 feet above water. This Radar target consists of two vertical, diamond-shaped planes made of metal mesh arranged at right angles to each other, with a third horizontal plane of similar shape and construction bisecting the two

vertical planes. The engineer boat anchors a buoy or a balloon at one end of the line to be measured and determines its position by measuring the distance between two or more known objects. The target boat is left standing alongside this marker while the engineer boat runs the line. As the engineer boat proceeds on line, its distance from the target boat is constantly available on the Radar dial, and at desired intervals on the course, temporary balloons or buoys are thrown overboard to mark points for instrument stations. The engineer boat continues on this course for several miles and sets a temporary buoy at the end of the line. The target boat then proceeds to the end of the first course and the same procedure is repeated on a new course. In this manner a closed traverse can be run, having three, four, or more sides, and the fix or position of each corner of the traverse can be determined by the engineering boat from known points. The ultimate range limit of the target boat depends upon the size of the target and the height of the transmitter and target above the water. The effective range of the present equipment is about 10 miles.

How Shoran Is Used

Another type of Radar equipment, called Shoran, can also be used to measure range or distance. Unlike the Mariner's Pathfinder equipment, which reflects Radar waves from the target, Shoran retransmits a Radar signal back to the sending station. The sending station transmits pulses alternately on different frequencies. These pulse groups are received at two receiving stations, sometimes called "transponders" or "beacons," which retransmit the received signal back to the sending station on a third frequency. The distance from the sending station to each of the transponders is read directly from dials which can be calibrated in feet. Since the positions of the two transponders are known, the fix of the sending station on the surveyor's boat is at the intersection of the two arcs swung around the two transponders. The error in measuring distance with Shoran is about the same as for other types of Radar equipment. A safe estimate of error is $\pm$ 20 yards, independent of distance measured, although claims to greater accuracy have been made.

This type of Radar is now being used for geophysical exploration and is giving satisfactory results. One disadvantage of this equipment and method lies in the fact that all the equipment is not centrally located, which causes greater difficulty in making repairs or minor adjustments. It also requires more personnel to operate.

(EDITOR'S NOTE.—For a more complete discussion of the use of Shoran in hydrographic surveying, see SURVEYING AND MAPPING, January-June 1947, page 16.)

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VEST-POCKET COMPASS

Circles from 2 inches to 12 feet in diameter can be made with the new vest-pocket size Flex-A-Beam compass manufactured by the Stewart-Jackson Instrument Company, Inc., Los Angeles, California. The compass may also be used to draw ellipses, spirals, and arches, as well as circles. The compass consists of a stretch-proof linen line on an aluminum encased reel. Three special push-pins are furnished which serve as center points for the compass. A releasing button permits the line to be drawn out to whatever radius is desired.—*The Military Engineer*, September 1947.

Nomograms for Computing the Orthometric Correction in Leveling

By ERNEST J. PARKIN

MATHEMATICIAN, U. S. COAST AND GEODETIC SURVEY

BECAUSE the earth is an oblate spheroid rather than a perfect sphere, level surfaces at different elevations above the datum of reference converge slightly toward the poles. It is therefore necessary to apply a correction, called the "orthometric correction," to differences of elevation determined by precise leveling so that the resulting elevations are the true elevations above the datum of reference. For the control leveling in the United States, this datum of reference is mean sea level.

A complete discussion of the orthometric correction is given in U. S. Coast and Geodetic Survey Special Publication No. 140, Manual of First-Order Leveling.

The formula for the orthometric correction to an observed difference in elevation is:

$$\text{Orthometric Correction} = Ch\Delta\phi$$

in which

C = a factor which varies with the latitude;
h = the average elevation of the section; and
$\Delta\phi$ = the difference in latitude in minutes, positive when the second bench mark is farther from the Equator than the first.

The present method of computing the orthometric correction at the Coast and Geodetic Survey is to multiply the three factors: mean elevation (estimated to the nearest 10 meters), $\Delta\phi$ (to the nearest minute), and C, a table for which has been computed and is given in the Manual. Since the Bureau's present requirements specify the placing of permanent bench marks at intervals of 1 mile along the route of the leveling, $\Delta\phi$ is very seldom greater than unity.

Nomograms have been devised by the author for the purpose of determining this correction. They eliminate the necessity of a calculating-machine or slide-rule operation and reference to the "C" table in the Manual.

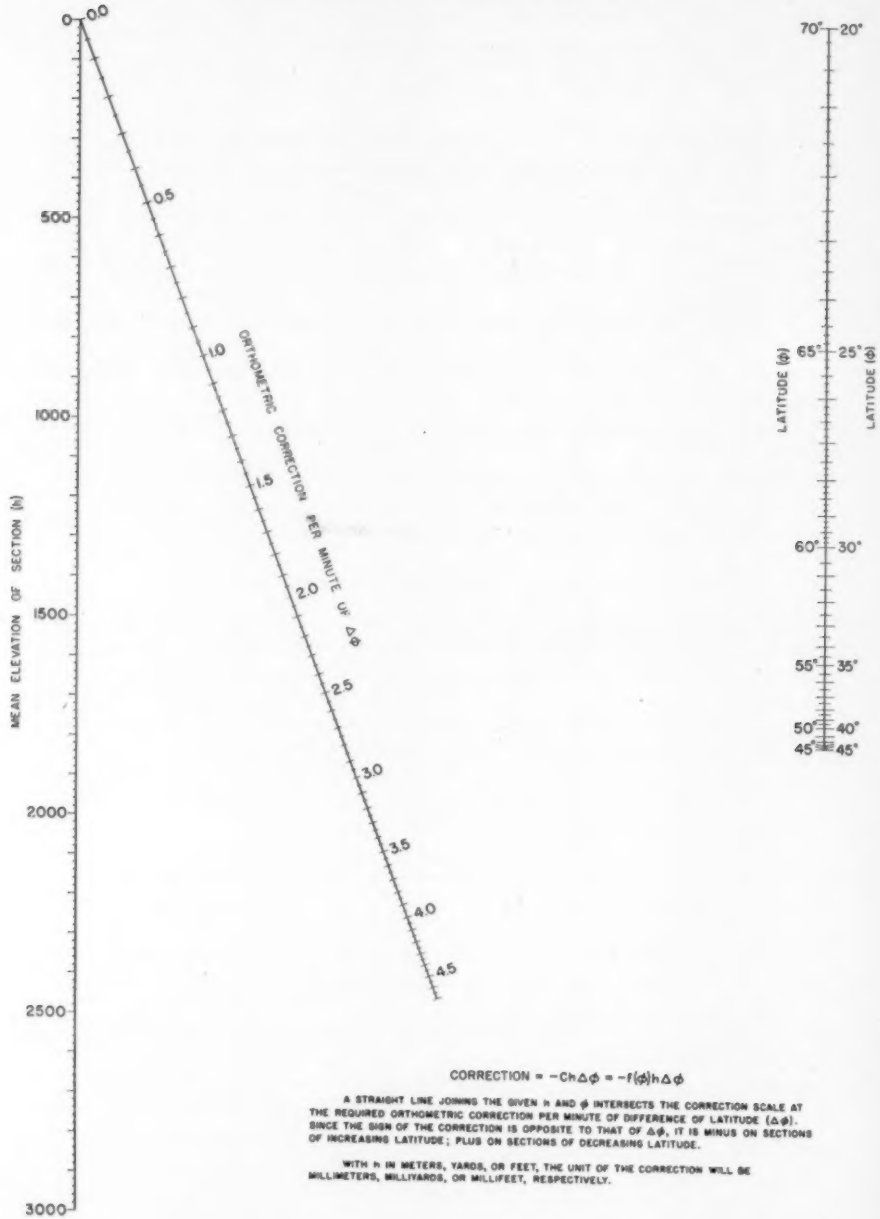
The accompanying nomogram, designed primarily for use in the continental United States, can be used between latitudes 20° and 70°. The values of C are not exactly symmetrical with respect to 45°, but for practical purposes the difference can be neglected. A straight line joining the given mean elevation (h) and latitude (ϕ) intersects the diagonal scale at the required orthometric correction per minute of difference of latitude. A straight line scribed down the center of a strip of some transparent material makes an excellent movable line for this purpose. If $\Delta\phi$ is greater than unity a simple mental calculation is sufficient to obtain the required correction.

A nomogram has also been designed for use between latitudes 5° and 20° for use in the Philippine Islands. It can also be used for latitudes 70° to 85°, if the need ever arises.

Publication approved by the Director, U. S. Coast and Geodetic Survey.

NOMOGRAM FOR THE COMPUTATION OF THE ORTHOMETRIC CORRECTION

FOR USE BETWEEN LATITUDES 20° AND 70°



$$\text{CORRECTION} = -Ch\Delta\phi = -f(\phi)h\Delta\phi$$

A STRAIGHT LINE JOINING THE GIVEN h AND ϕ INTERSECTS THE CORRECTION SCALE AT THE REQUIRED ORTHOMETRIC CORRECTION PER MINUTE OF DIFFERENCE OF LATITUDE ($\Delta\phi$). SINCE THE SIGN OF THE CORRECTION IS OPPOSITE TO THAT OF $\Delta\phi$, IT IS MINUS ON SECTIONS OF INCREASING LATITUDE; PLUS ON SECTIONS OF DECREASING LATITUDE.

WITH h IN METERS, YARDS, OR FEET, THE UNIT OF THE CORRECTION WILL BE MILLIMETERS, MILLIYARDS, OR MILLIFEET, RESPECTIVELY.

These nomograms were designed principally for use by the Coast and Geodetic Survey where the metric system is used. With h in meters the resulting correction will be in millimeters. They can be used with equal facility, however, with h in yards or feet, in which cases the resulting corrections will be in milliyards or millifeet, respectively. Furthermore, they are usable in either hemisphere.

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Bikini Scientific Resurvey

THE NAVY reoccupied Bikini Island on 15 July, just 355 days after the underwater atomic bomb blast sent a mile-high column of radioactive sea water crashing down on the Operation Crossroads target fleet.

First man ashore was Capt. Christian L. Engleman, USN, project officer for the Bikini Scientific Resurvey. He led a party of radiological monitors, scientists, and military technicians on an exhaustive and thorough search of the island.

Geiger counters indicated some radioactivity on the beach, but the amount recorded was not significant. Stronger amounts of radioactivity were noted on life rafts and on other gear cast up on the beach. It is believed some of this material may have drifted ashore.

Installations on Bikini, including buildings and construction equipment left on the island when it was abandoned last year, were found to be in good condition. Three of the small pontoon type docks used by the Crossroads Task Force remained operative.

Many flies, spiders, moths, crickets, butterflies, and ants were noted by the inspection party. A member of the scientific staff caught a small lizard. Black-tipped shark and several species of brightly colored tropical fish could be seen in the emerald-clear water around Bikini docks.

Vegetation on the island appeared unchanged from last summer.

Captain Engleman said a careful examination of Bikini Island indicated that it had been unoccupied by human beings since the last Crossroads personnel departed in 1946. Several members of the inspection party reported finding fresh dog tracks in the sand. These may have been made by one of the puppies born on Bikini Island during the Baker Day blast last year. It is not known whether or not all those puppies were evacuated when Crossroads personnel left the island.

It is planned to establish a Seabee camp on Bikini.—*Army and Navy Journal,* July 19, 1947.

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Precision Plumb Bob

A QUICK-ACTING, precise plumb bob for use by carpenters, mechanics, construction men, surveyors, and so on, has a rotatable reel at the neck. Cord is reeled off to the approximate length wanted, and then slipped into a hook on top of the neck, which holds bob exactly centered anywhere on the cord. The bob can then be minutely adjusted up and down simply by rotating the spool. When not in use, the spool and hook hold the cord neatly and securely in place, even with the bob carried loose in a tool box. Rugged and simple in construction, there is nothing to get out of order, even when working in wet mines.

Carefully engineered and thoroughly field-tested, this Micro Plumb Bob is constructed of dense, forged brass, with a steel point, heat treated for toughness and hardness. The popular 10, 12, 14, and 16 ounce sizes are available, and each bob is supplied with tool-steel pin, cord, and an additional precision point.—*Scientific American,* June 1947.

British Commonwealth Survey Conference

THE FIRST postwar British Commonwealth Survey Officers' Conference was held August 18–29, 1947 in London, England. Such conferences were held about every 3 years before the war, and the purpose was to give those in charge of surveys an opportunity to discuss mutual problems and to exchange ideas.

During World War II, Great Britain and the United States collaborated closely in this field and in many war theaters. American officers were closely allied with their "opposite numbers" in Great Britain and in the various dominions and colonies. Because of this the United States was invited, through the British Ambassador, to send representatives of its principal mapping agencies to the conference as observers. The American delegation included the following: Gerald FitzGerald (Geological Survey), *chairman;* Captain K. T. Adams (Coast and Geodetic Survey); James J. Deeg (Photographic Laboratory, Wright Field); Lt. Col. Albert G. Foote (Aeronautical Chart Service); Otto E. Guthe (Division of Map Intelligence and Cartography, Department of State); Commander George F. Kennedy (Hydrographic Office); Col. John G. Ladd (Office of the Chief of Engineers); Col. William H. Mills (Army Map Service); and Marshall S. Wright (Research and Development Board).

About 150 officials attended the conference. The London meetings were at Seaford House, Belgrave Square. Included in the conference were arranged tours of inspection to the nearby offices of the Ordnance Survey, the Directorate of Military Surveys, the Directorate of Colonial Surveys, the Survey Production Centre, and to the more distant activities of H.M.S. *Scott* at Great Grimsby, Messrs. Cooke, Troughton, and Simms at York, the Hunting Aerosurveys at Elstreet, Greenwich Observatory, and the R.A.F. Central Photographic Establishment at Benson.

Major General G. Cheetham, Director of the Ordnance Survey, was President of the Conference and a different chairman presided each day. All sessions were fully attended. Copies of all formal papers were available in advance of the meetings and each paper was followed by discussion. The intention is to publish the full proceedings, including the pertinent discussion. Most papers dealt directly with some phase of surveying and mapping and were in almost every case of interest and value to the American observers.

It is apparent that the British Empire as a whole is much more map-conscious than the United States. Most of the delegates to the conference were recognized authorities in surveying and mapping, and the dissemination of knowledge and the personal exchanges of experiences which were possible at such a conference can only result in accelerated progress of surveying and in better maps.

The sponsors are to be congratulated on such a successful conference. The challenging thought that occurs is, of course, why can't the United States hold a future conference of this kind and reciprocate by inviting interested observers to attend? The American Congress on Surveying and Mapping could logically sponsor such a conference.

—K. T. ADAMS

"Yes, that's about the right distance—but then I wonder what Latitude or Longitude I've got to?"

—*Alice in Wonderland*

Radar on the Chesapeake

By S. B. CHAPMAN

CAPTAIN, *City of Richmond,* OLD BAY LINE

EVERY TRIP I have made between Baltimore and Norfolk since Radar equipment was installed on the *City of Richmond* last spring has been as easy as if made on a bright, clear day. When it comes to a navigational aid Radar is tops. The other night we made the trip in a dense fog and as we cruised along on our course, guided solely by the location of images on the Radar scope, I couldn't help but recall a similar night a few years ago, before we knew of Radar.

Target lights were of no help at all. When we reached one buoy we would simply set our course for the next one, keep going until the time allowed for the distance had elapsed, then start looking for the buoy. This worked for a time, but finally after one 40-minute run, when the buoy didn't show up where it should have been, we cut speed from half to slow and steamed on for several more minutes, when suddenly a buoy was sighted off the port bow. According to the chart the buoy we were looking for had no business being on the port bow so we knew we were definitely past our course buoy. Also, we knew enough time hadn't passed to reach the next charted buoy so we decided the safe thing to do was to drop anchor and wait for the fog to lift.

I was about to give the order when we heard a ship's bell off to starboard. We changed our course, and soon sighted a Coast Guard vessel at anchor. I hailed her and asked the officer of the deck for information. He gave us our location, told us that the uncharted buoy had been placed there that day by the Navy. Then he said: "Wait 'till I look at our Radar." In a few seconds he was back, gave us bearing and distance to the next buoy. We hit it exactly, approximately 50 minutes later. The fog area ended a short distance beyond the buoy, and we reached Norfolk on time.

I made up my mind then that this Radar thing was a mighty handy instrument to have on a ship. My experience with Radar on the *City of Richmond* has strengthened that opinion.

The ships of the Old Bay Line operate every day of the year carrying passengers and freight between Baltimore and Norfolk, both busy harbors. Anchorages are crowded and there is considerable traffic, including everything from ocean freighters to small fishing craft and pleasure boats.

For the first 18 miles of our run from Baltimore we have a winding dredged channel a few hundred yards wide. Water on either side is dangerously shallow even for the *City of Richmond,* which draws approximately 15 feet. In the Bay itself there is a wide, natural channel but the shape of the Bay and the numerous islands make frequent changes of course necessary during the next 150 miles. Traffic difficulties are less than in the harbor areas, but are still considerable. Railroad ferries run between points on the Eastern Shore and the Virginia coast; oil tankers are numerous, as the communities along the many rivers which empty into the Bay are served in this way; tugs and barges are frequent.

About 12 miles from Norfolk is another dredged channel, the course of which

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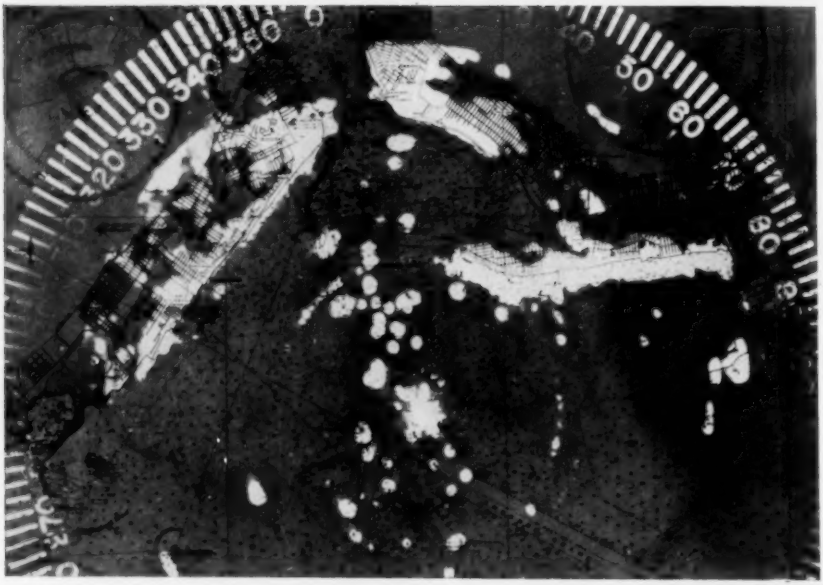

U. S. Coast Guard

FIGURE 1.—A composite picture of the chart and the Radar scope aboard a vessel approaching the entrance to The Narrows in New York Harbor. Distortion may be due to difference in scale and lack of specific target in low shorelines.

resembles a figure 5 lying on its side. Outside of this channel the water is extremely shallow, traffic conditions akin to those in the Baltimore harbor.

We leave Baltimore early in the evening and reach Norfolk the next morning. During the day we touch at the piers of the various railroads running out of Norfolk. We leave Norfolk in the evening, arriving at Baltimore the following morning, the only intermediate stop being at Old Point Comfort.

With weather clear the chief value of Radar is that it extends the range of vision, particularly in regard to other ships. It gives a definite idea of what is ahead long before seen from the bridge. We know the distances from us and even when in sight the Radar distance is more accurate than the estimate of the most experienced officer.

The value of Radar when visibility is poor, especially in a fog, cannot be overstated. It is not unusual to pick up a buoy on the Radar scope at a distance of 3 miles or more, and to pass it exactly as we wish even though not visible until a few hundred feet away.

Some people have the idea that the Radar screen shows a picture of the object. This is, of course, not the case. What appears on the scope is a blob of light, corresponding to the shape of the object, which must be interpreted. (*See* fig. 1.)

Interpretation, however, is not difficult. We have had many visitors on the *City of Richmond* since our Radar was installed and I have seen men who had never been on a ship before learn to recognize many of the shapes after a few

hours' experience. For a seaman it is still easier. We are in the habit of identifying landmarks when all we can actually see is an irregular shadow. A certain pattern of running lights is recognized as a ship and we can tell its size, direction, and many other things about it.

Reading the light-patterns on a Radar scope is the same kind of a problem. Land areas show up as feathery masses. Shorelines are clearly outlined, as is land farther back, provided it is higher than the foreground. Ships may sometimes be very accurately outlined but more frequently they appear as roughly oval shapes. Buoys appear as distinct circular dots. They are, naturally, quite small. A tug towing a barge makes a different pattern than that made by separate ships.

The image on the scope changes constantly. Thus it is easy to determine whether ships are moving or at anchor, their bearing and distance, and the direction in which they are moving. A very accurate idea of their speed can also be obtained.

The point to be emphasized about all this is that Radar brings this information as clearly in the densest fog as in bright daylight.

It must not be assumed, however, that Radar is in any way a substitute for knowledge and skill. You still have to know your route and how to handle your ship. What Radar does do is to extend the range and increase the accuracy of your observations. I have already mentioned its value in locating buoys long before they are visible, but let's take another case. Suppose, in a fog, you hear a ship's bell. It is always hard enough to be sure of the source of a sound but even if you were sure you would need to know more. The sound may be outside of the channel but the ship may have swung broadside across it. Without Radar, you reduce speed until you find out; with Radar you know, long before you even hear the bell. With or without Radar, reduced speed in a fog is merely ordinary prudence, but with Radar you can maintain that speed steadily; and the elimination of stopping and groping means an appreciable saving of time. The *City of Richmond* is still late at times, but less late and less frequently than in our pre-Radar days.

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Collars Make Buoys Easy to See at Night

REFLECTING COLLARS, that fit around harbor, bay, and river buoys to mark shipping channels, make the anchored warning floats more easily seen at night when searchlight beams fall on them.

The principle employed is similar to that used in roadside reflectors to warn automobile drivers. Their installation has been revealed by the U. S. Coast Guard which already has several thousand in place on New England waters and in the Mississippi River area.

The reflecting material is sheet metal and is either red or black, depending upon the color of the buoy. In the surface of the metal band are many small crystals that cause the reflection. These buoys are visible at all angles because the minute crystals reflect light beams striking them from any direction.—*Science News Letter,* August 23, 1947.

Information Sources for Surveyors and Mappers

By FORREST DANIELL
CIVIL ENGINEER, THE TEXAS COMPANY, HOUSTON, TEXAS

"OTHER professions have vigorous current literature in which the members exchange views and ideas, and develop new procedures, methods, and practices. Our profession has been content to remain secretive and fixed. We have been inclined to oppose change, and to resent exchange of opinions. As a result, we lack the unity of other professions. We lack a uniformity of practice and procedure." The above quotation from one of our members, S. A. Bauer, is worth repeating.

As a result of new techniques developed during the recent war—especially those involving radio detection and ranging—the surveying profession has become aware of the possibilities of the use of these techniques. For example, the petroleum industry has been using Radar in its oil explorations in the Gulf of Mexico. Eventually the precise location of oil well sites many miles from shore will be determined by the use of improved Radar equipment.

Since in our profession there are many surveying divisions, such as precise, control, property, topographic, and aerial, every surveyor should be aware of the background of the profession as a whole and of the processes which provide the basis of work for each division. Each surveyor or cartographer should keep himself constantly informed on new technical developments in his own field and in those which are related to it.

The primary sources of technical information pertaining to the surveyor and the cartographer are periodicals and books. The periodicals usually are in the form of magazines, bulletins, and society proceedings. Among many others are *Surveying and Mapping, The Canadian Surveyor, The Military Engineer, Civil Engineering, Empire Survey Review, North Carolina Engineer, Proceedings of the American Society of Civil Engineers,* and the reports of the Texas Surveyors Annual Conferences. The books range in content from the usual textbooks on land surveying to the various government manuals.

The secondary sources of technical information concerning surveying and mapping are the abstract bulletins and bibliographies prepared by various organizations, companies, and publishing houses. The Engineering Index published annually and found in the larger libraries is a very useful abstract journal. The various college engineering experimental station bulletins also furnish information on new technical developments on subjects related to surveying and mapping.

There are several methods by which a surveyor can keep informed of current developments, standard procedures, and other informative subjects. He may prepare abstracts, adequately describing in a few words the type and content of books, bulletins, pertinent articles, and reports. Another method is the search report in the form of annotated bibliographies. In this method, the researcher finds all of the literature dealing with some desired phase of surveying or mapping, obtains or prepares abstracts thereof, and then arranges them in a logical order. Usually a copy of the literature is attached to the report for future study.

The surveyor or cartographer, to be better informed on the latest developments in his field of work, may attend the annual conferences on surveying and mapping usually sponsored by national organizations or by the engineering colleges of the state in which the conference is held. The purpose of these conferences is to bring together the engineers, surveyors, officials, and others who are interested in surveying and mapping, in order that they may not only hear various phases of problems arising in such activities discussed by experts of state and national reputation, but also that they may have an opportunity to meet with each other and exchange ideas.

And last but not least, the surveyor or cartographer should be a member of the American Congress on Surveying and Mapping. Its quarterly journal, SURVEYING AND MAPPING, furnishes persons interested in surveying and mapping not only articles on current surveying topics, but also bibliographies on related articles both as to magazines and books. This journal is at its best in informing its members what government surveying and mapping information is available, where the information may be found, and how to procure it.

New Camera Photographs Radar Readings

A NEW use for radar in marine navigation promises insurance interests a high stake in its adoption by ship owners. Recently the value of radar has been extended to collect permanent data on ship positions and routes, presenting visual irrefutable log data and legal evidence by photographing images as flashed on the radar oscilloscope.

Radar photography is achieved by an especially designed electrical camera, the Mirar. Developed by the Fairchild Camera and Instrument Corporation for use with all makes of shipborne radar equipment, the Mirar automatically records every light and shadow seen by the radar receiver. During periods of fogs and darkness, just as on the clearest, calmest days, it records waterways objects and land masses, accurately showing distance and bearings of all the "targets" presented on the 'scope. Such radar photographic data is provided merely by flicking a switch.

The camera, using 100-foot rolls of 35-mm. film, takes 1,600 individual exposures per roll. Through an ingenious device, the intervalometer, Fairchild has provided for automatic exposures at intervals ranging up to as often as one picture for each pulse of the radar.

When making a complete radar chart of any harbor or waterways condition, the camera photographs a wealth of significant detail such as the ship's position and heading, its progressive route in relation to nearby intersecting vessels, a placing of all fixed obstructions, such as docks, bulkheads, buoys, anchored vessels, and bridges, and the exact position of any possible accident or catastrophe in its relation to the shoreline. Radar photographs also provide a method of computing the speed of the vessel because the exact time and distance are recorded on each photograph. Distances covered are those obtained from the radar. Usually photographs will cover distances approximately 2 to 8 miles in diameter. All photographs are automatically numbered in sequence.—*The Nautical Gazette*, September 1947.

Map Copyrights

By JAMES M. VOTAVA

GENERAL COUNSEL, RAND MCNALLY & COMPANY

OWING to the general trend toward greater employment of visualization in presenting the sales message, the use of maps in advertising and promotion material has been on the increase for several years. A possible contributing factor of more recent origin is that many advertisers are seeking to capitalize the enhanced public interest in maps of all kinds that always accompanies a period of warfare and alterations in world boundaries.

Whatever the cause of the increased use, there is little question about one of the effects. The misuse of maps, from the standpoint of the legal rights of their creators, has multiplied at least in proportion. By some quirk of human nature, few people ever seem to acquire a practical awareness of the importance of observing the protection which the law affords to the cartographer. The result is a possible unpleasantness—and a possible expensiveness—that is wholly avoidable and unnecessary.

Seemingly, and not too unreasonably, the average person's attitude toward a map goes something like this. The State of New Jersey, to take a random example, is after all simply the State of New Jersey. Everybody knows what it looks like and recognizes its shape. The boundaries always remain the same and such components as cities and towns don't move around from place to place. A geographical diagram of the area is based on public sources to which everybody may have access. Nobody has exclusive rights to drawing pictures of it. Furthermore, most of us feel that when we go out and buy a map it becomes our absolute property. It is ours to color or letter or stick pins in or sell or give away or tear up as we please.

Much of this viewpoint is essentially accurate. A great many maps are indeed based on sources available to anyone. A person might very easily go to the same sources used by a map company and, assuming he used the same methods of projection, end up with a map that would be exactly the same in all important respects. But the point is, in the average map user's case, he doesn't do that. Somebody else did it and he bought a copy of what that somebody else—the map company—spent time and labor and money to do. Having paid the asked price in a perfectly legal sales transaction, he owns the map to do with it as he likes up to one certain and very critical point: he must not reproduce that copy in any way.

Practically all maps made by American map publishers are copyrighted and thereby protected by federal law against copying or reproduction, without the permission of the copyright owner.

The Copyright Law

Although the present copyright law has been on the federal statute books since 1909, and was preceded by similar laws for at least 200 years, many people whom the law does or can affect are seemingly hardly aware of its existence. For a law that covers so broad a field of human activity, the fundamentals of

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the existing statute are comparatively simple and easy to understand. There is no reason for anyone with even a cursory knowledge of its provisions to infringe upon a copyright unwittingly. And few persons acquainted with the penalties which can be imposed upon the infringer of a copyright will fail to respect such rights.

Let's see what the copyright law is. Setting aside its legal phraseology and ignoring for the moment the more technical portions of the statute and court interpretations of it, the law provides that anything capable of visual expression which is new, i.e., which has not previously been copyrighted or is not already "in the public domain," can be copyrighted. This includes maps. "In the public domain" means, briefly, "common knowledge" or "common property." The law assures to the creator of a map that some other person or institution cannot copy or reproduce his work without his permission. The original drafting and plates for a map may represent the investment of several hundreds or thousands of dollars, although intrinsically a single copy has a value of but a few cents.

Avoiding Copyright Infringement

With that hasty review of the law as a background, here is a list of points for advertisers to bear in mind when dealing with maps:

1. Reproduction of a map without permission of the copyright owner must not be made in any way. It is fairly well understood by advertisers—although the record is far from perfect—that this covers advertisements in publications. But that is not all. It is not entirely uncommon for a sales manager or advertising manager to purchase a single copy of a copyrighted black-and-white map of a region, enter upon the map information pertinent to his business, and then send the marked-up map or a portion of it to a photographer, planographer, photostater, or engraver and order a quantity of reproductions of it. This is just as much an infringement as is a publication advertisement.

2. The law applies to any quantity whatsoever. To send out a half dozen reproductions of a map bearing sales information to branch managers may seem no violation, but it is. Actually, to make even a single carbon copy of a copyrighted map is an infringement.

3. Do not assume by the absence of a copyright notice on a map that it is not protected by copyright. The notice may have been removed before the map reached your hands. The map—and this is a pitfall that often leads to trouble—may be only a section removed from a copyrighted map. Again, the copy which you have received may itself be an infringement from a copyrighted map. In any of these instances the map is still protected and you are infringing if you copy or reproduce it. The safest policy is to assume that every map is copyrighted unless you have the assurance of the original publisher that it is not.

4. All who participate in an infringement, whether innocently or not, are equally guilty and jointly and severally liable for damages. This includes engraver, printer, planographer, publication proprietor, and advertising agency, as well as the advertiser himself.

5. A person guilty of an infringement is liable to an injunction restraining such infringement. He can be made to pay such damages as the copyright owner may suffer as well as all the profits which the infringer may make from such infringement. If the copyright owner finds it impossible or impractical to show actual damages, the court may award statutory damages (fixed amounts set by statute) in lieu of actual damages. It is a misdemeanor, punishable by imprisonment or fine or both, wilfully and for profit to infringe a copyright.

Reproducing Copyrighted Maps

Most map publishers are quite reasonable about granting permission to repro-

duce their copyrighted maps, although they prefer to make such special reproduction themselves. Naturally they demand that permission be obtained before any reproductions are made, and require also to know the nature and purpose of the reproduction. The fees charged for such permission are generally fair and reasonable, varying with the number and kind of reproductions to be made.

While reputable map publishers have no desire to become involved in infringement proceedings, they must, as a matter of self-preservation, be eternally vigilant in detecting and preventing infringements of their maps. Should they permit infringements they would, in effect, forfeit their property rights in their maps and soon be out of business.

Distasteful as the task is, the map publisher has no alternative but to enforce his copyrights. So, when an infringement comes to his attention, his first step is to contact the infringer and attempt, in a friendly and fair manner, to persuade the infringer to cease the infringement and reimburse the copyright owner for any damage or loss of revenue he feels is due him. If such friendly efforts do not effect a satisfactory settlement, the matter is usually put in the hands of a copyright attorney for whatever legal action is necessary.

It is to be understood, of course, that the attitude of map makers is by no means unfavorable to employment of maps for special purposes. On the contrary, most publishers naturally desire and urge that their maps be given the widest possible use. The majority maintain facilities for reproducing maps with the addition of such special data as may be desired.

The cardinal principle for avoiding map difficulties may be summed up as this:

> Never participate in any way in the copying or reproduction of a copyrighted map or a section of a copyrighted map without consulting the copyright owner, and unless the latter is to make the copies, be sure that written permission is obtained.

* * *

Three-Dimensional Pictures

A CAMERA that takes three-dimensional pictures is announced by the Navy as the outgrowth of two years of research at the Naval Aircraft Experimental Station in Philadelphia. An ordinary eight-by-ten inch negative is run through a special roller which indents it with from two thousand to three thousand lines, or ridges, almost microscopic in depth. These are said to create nearly a million tiny individual lenses in the film, which, in conjunction with the wide ten-inch lens of the camera, "almost literally have the ability to see around corners of the subject being photographed" and thus to create three dimensional perspectives. In the printing process an enlarger, provided with a bellows, is used. A fluorescent light flashes behind the negative and the bellows moves up and down so that the paper will "see" the image from various angles, as seen originally by the lens. For this invention it is claimed that no other conventional type of camera has been developed for taking three-dimensional pictures nor a process discovered for making prints. Both the film and the prints show in three dimensions without the use of any special viewing apparatus. The printing "paper" is not strictly paper but film treated with a special paper emulsion. The goal of the new instrument is all-round use in the military services, and the suggestion is made that its potentialities, especially for war-time aerial work, are vast.—*Think*, September 1947.

Federal Surveying and Mapping Agencies

This is another in the series of sketches of the history, purpose, and scope of activities of federal agencies engaged in surveying and mapping.—EDITOR.

THE ARMY MAP SERVICE

War Department

ORGANIZATION AND HISTORICAL BACKGROUND

IN ACCORDANCE with Army regulations, the Assistant Chief of Staff, G-2, War Department General Staff, is charged with the development of plans and policies for military mapping. Responsibilities toward the consummation of outlined methods and procedures specified in subsequent directives infiltrate through the chain of command; first, through the Military Intelligence Division, Office, Chief of Engineers, and then to its principal cartographic echelon, the Army Map Service, which turns out the end product—modern military maps. The Commanding officer and his military staff are selected from engineers who have shown aptitude for topographic pursuits. Its civilian personnel is composed of specialists mainly in the fields of cartography, photogrammetry, geodesy, geology, toponymy, model making, and photolithography.

Although the organization was christened the Army Map Service just a year prior to World War II, its birth can be traced from the early days of American history when the Topographical Corps was activated.

During the first World War, the organization was known as the Central Map Reproduction Plant. At that time, it was expanded somewhat to anticipate a map supply crisis—an emergency which did not materialize, since topographic units of the American expeditionary forces were not unduly pressed to meet mapping requisites incidental to static trench warfare. A comparison of the 9,000,000 maps needed for World War I and the almost 500,000,000 produced during World War II indicates how the mold had changed. As the Army Map Service, the organization had a much more complicated task than as the Central Map Reproduction Plant. The increase in the quantity of maps necessary for World War II is an index to modern conflict's increased mobility and military cartography's adaptation of techniques to cope with resulting mapping problems.

Soon after World War I, the organization was rechristened the Engineer Reproduction Plant, a name not particularly definitive of the functions it performed. This stage in its metamorphosis was a result of a merger of the Central Map Reproduction Plant, the Central Photographic Laboratory, and the Engineer School Press. A converted warehouse within the environs of the Army War College tract at Washington, D. C. housed the somewhat meager facilities and limited staff engaged in map drafting and reproduction. Most of the Engineer Reproduction Plant's personnel and equipment were being utilized in the drafting and repro-

Prepared in the Publication Section, Army Map Service, Washington, D. C.

duction of quadrangle sheets, at scale 1:62,500, of domestic areas falling within the scope of the Corps of Engineers' responsibility. Publication of maps covering military posts and camps at scales ranging from 1:5,000 to 1:25,000 shared importance with those quadrangles. Progressive Military Maps of United States territorial areas were compiled, drafted, and published. The Engineer Reproduction Plant also assisted materially toward the publication of many of the maps which the Mississippi River Commission was preparing as plans or records of flood control and river navigation.

During these peace years, numerous experiments were undertaken to develop new, and improve old, cartographic and photolithographic processes. The blueline board method of color separation drafting was adopted as standard practice. Experiments with type faces effected a compromise in characters which maintain legibility under extreme conditions in photolithographic procedure. Tests with various adhesive stocks resulted in an almost general acceptance of transparent material for the application of place names to drafted copy. Investigation of other reproduction processes returned the Engineer Reproduction Plant to its original choice, photolithography. Intensive research into that branch of the graphic arts resulted in the perfection of many of the techniques which made possible eventual map production in unprophesied quantities.

The War Years

A hint of the expansion to come and its accompanying problems became manifest in 1938 when the Engineer Reproduction Plant, utilizing WPA funds and personnel, began the preparation of an 87-sheet 1:500,000 scale Strategic Map of the United States. The completed map was good. But more important were the lessons learned and the techniques developed. It was necessary to institute a new scheme of operations, for the WPA personnel consisted of men and women who had little knowledge of cartography and were unskilled in even the simplest tasks of the compiler and draftsman. An assembly line procedure was adopted, patterned after industrial work-simplification. Operations were reduced to a series of relatively simple tasks and each person indoctrinated in one specialized phase of work. The development of this system was a positive step toward insuring a sufficient map supply for World War II.

Just prior to Pearl Harbor, a comprehensive mapping program was initiated to insure large-scale map coverage of strategic domestic areas. This program could not have been accomplished without the whole-hearted cooperation which was furnished by other government agencies and private contractors.

The most salient passages of Army Map Service history apply to its mission during World War II. Following Pearl Harbor, expansion was remarkable but qualified by unusual circumstances. Sections of a dozen people mushroomed into departments ten times greater to activate a work tempo matching the pace and need of national emergency. Branch offices were established throughout the United States as invasions of enemy countries required many more maps than the base plant could furnish. Other government agencies were called upon for help and independent mapping establishments and lithographic firms were allocated projects by contract in order to "accomplish the impossible."

Among the many problems that confronted the Army Map Service as war became imminent was the status of its map library holdings. Lack of adequate source maps as basis for compilation precluded the construction of suitable maps

of vital foreign areas. When the library was transferred from the War Department General Staff to the Army Map Service, its collection totaled approximately 200,000 items. Routine acquisitions added some 8,000 annually. Few, if any, countries were represented by complete sets of maps, especially in critical European and Asiatic areas.

Some months prior to Pearl Harbor, steps were taken to rectify this condition. Representatives were sent out to prospect in libraries, institutions, and private organizations, to ferret out anything remotely resembling a map. Map curators, missionaries, geodesists, surveyors, oil companies, geologists, and adventurers were persuaded to supply or lend the needed material.

More beneficial with respect to accumulation of source material for that time and the future, was the co-ordinated agreement between the Geographical Section, General Staff, of the British War Office, and the Chief of Engineers. The nature of this pact was to divide map supply for the Armed Forces among Allied Nations. The future proved it a prime necessity where combined operations were the order of each D-Day.

Expansion of the library was a reflection of the enlargement and reorganization of all sections. Extensive recruiting was initiated. Workers possessing skills of varying degree and calibre were fitted into the scheme as their abilities warranted. Courses of instruction were designed to train inexperienced personnel in the basic tasks of all branches. When Selective Service demanded its masculine quota, women competently replaced them. The peak of wartime employment by the Army Map Service and all its affiliates represented 1/26,000 of the total population of the United States. Their efforts created a flow of 41,000 map sheets from preliminary stages through final distribution. Were it possible to accumulate and stack the 491,000,000 copies of these sheets published during the 4 years of World War II, the pile would rise 297 times the height of the Washington Monument. Their 24,550 tons would slightly overbalance the weight of two prewar cruisers.

Postwar Years

Following V-E Day, the Army Map Service experienced the first in a chain of its latest reorganizations—conversion, rather than curtailment, was the keynote. Emphasis was shifted from revision of existing maps to production of new maps. The techniques which produced and distributed millions of maps to all theaters of operations were geared to serve a postwar program requiring more map sheets in smaller quantities. The needs of occupational troops would be less than the demands of invasion forces, but the training of military personnel would still include courses in map reading and map construction. The Army Map Service continues to supply items of cartographic curriculum.

The most obvious manifestation of change in the Army Map Service since the end of the war is its reassignment and redistribution of personnel. In line with the change in methods characterized by more qualitative techniques, personnel were reassigned to jobs suited to their best developed skills. Enlargement of some sections and the establishment of others have altered the appearance, but not the basic principles of the Army Map Service. Photogrammetry, which before World War II was a relatively minor function, has assumed a major share of peacetime activity. From a small section formerly contained within the Cartographic Division, it has grown to divisional status, encompassing all the duties

which involve aerial photography as medium or adjunct. The Cartographic Division has also received considerable expansion.

Most influential in the new organization is the factor of turning to the accuracy demanded by normal standards in contrast to the emphasis upon speed engendered by concentrated and rigid schedules. Specifications are more exacting as the pressure of time defers to preciseness of detail. Design signifies more than adherence to a few temporarily basic formulas. Map research means more than a hasty accumulation of data easily gathered. The impossible due dates which preceded a series of historical D-Days no longer goad the tempo of production. The Library's collection has enlarged to more than 800,000 items. Its system of establishing adequate and wide-spread depositories assures research students and cartographers sufficient cartographic data throughout the United States.

The talented assistance and complete co-operation of such agencies as the United States Geological Survey, the Tennessee Valley Authority, the Soil Conservation Service, the United States Coast and Geodetic Survey, the Hydrographic Office, the Forest Service, and several non-governmental photogrammetric and lithographic firms were essential to the accomplishment of the Army Map Service's wartime mission. They are equally essential to achievement of its peacetime program.

* * *

Board on Geographic Names Established

OF INTEREST to surveyors, mappers, geographers, and others who deal with place names, is Public Law 242 of the 80th Congress, approved July 25, 1947. Described as "an Act to provide a central authority for standardizing geographic names for the purpose of eliminating duplication in standardizing such names among the Federal departments, and for other purposes," it establishes a Board on Geographic Names, under authority of the Secretary of the Interior, thus giving legislative status to a function that has been carried on since 1890 under various Executive orders. The Act abolishes the former United States Board of Geographical Names and transfers its duties to the new Board.

The new Board is authorized to formulate principles, policies, and procedures to be followed with reference to both domestic and foreign geographic names, and to determine the standard names and their orthography for official use. All departments, bureaus, and agencies are required to refer matters concerning geographic names and problems to the Board, whose decisions and principles shall be standard for all material published by the Federal Government.

The principles and policies formulated by the Board will be designed to serve the interests of the general public as well as the Federal Government, and full consideration will be given to specific interests of particular federal and state agencies.

Membership on the Board includes one representative from each of the Departments of State, War, Navy, Post Office, Interior, Agriculture, and Commerce, and from the Government Printing Office and the Library of Congress. Provision is made for additional representation from federal agencies, and for the ap-

pointment of advisory committees of experts from outside Government to assist the Board in the solution of special problems. Members will serve for a term of 2 years, but reappointments may be made for successive terms.

Since the passage of the Act, the status of the Central Intelligence Agency and of the Army Air Forces has been altered and they have been given representation on the Board.

* * *

A College-Federal Service Council

CLOSER CO-OPERATION OF COLLEGES and universities with federal agencies is the aim of the newly organized College-Federal Service Council, which covers the Second Civil Service Region of New York and New Jersey. At a conference of the Council held in New York City, a plan was proposed for working out a program whereby federal agencies can compete successfully with other employers for best qualified college graduates. Spokesmen for federal agencies agreed unanimously that high-caliber graduates are needed, especially in the fields of engineering and the physical and biological sciences.

During the conference, which was attended by representatives of metropolitan schools, various suggestions were advanced for accomplishing this aim:

1. Use students during summer vacations to get federal experience, and from the best trainees select those for permanent positions. Also a program was suggested whereby students would be permitted to complete college studies while holding federal positions.

2. Compile registers of eligible candidates prior to graduation so that federal positions can be offered to members of the graduating class before they actually leave school.

It is expected that as soon as the organization is fully set up, local committees will be established to represent federal agencies and schools in their respective communities.—*Civil Engineering,* April 1947.

* * *

Accurate Time

AT KHARKOV, RUSSIA, a perfect time-keeper, precise to 1/10,000 of a second, has been installed, and others will be placed at Leningrad and Moscow this year. All will be wired together. The timing is done by a small quartz plate in which is produced a definite frequency of electrical vibration up to 100,000 per second, depending on the size of the plate. The impulses from this electric-vibration generator operate a small motor, which in turn operates a clock that can run without stopping for several years.

Such a clock is more accurate in time-keeping than is the rotation of the earth around its axis. Using the clock, Soviet scientists have already observed small irregularities in the earth's rotation.—*Science Illustrated,* July 1947.

MAP INFORMATION

This department was inaugurated for the purpose of bringing to the attention of the members information pertaining to the availability of maps, surveys, etc., with particular emphasis on how such material can be procured. Authoritative articles covering this class of information are solicited. It is believed that through an interchange and dissemination of such information maximum benefits will accure to the surveying and mapping profession. —EDITOR.

Maps of the Mississippi River

THE 15th (1947) edition of "Maps of the Mississippi River—Cairo, Illinois, to the Gulf of Mexico, Louisiana," has recently been issued by the Mississippi River Commission, Corps of Engineers, U. S. Army. Republished annually, this set supersedes all editions subsequent to 1933. The bound folio is 13 by 20 inches in size and contains 62 detail maps and a number of supplemental sheets, giving various types of information.

The detail maps cover distances from 1 to 8 miles on either side of the river and are constructed at a scale of 1:62,500 (about 1 inch to 1 mile). They show the shoreline, corrected from latest surveys by District Engineers; the mean low-water line, representing the bank line at low-water stage; the location of the channel line; the location of navigation lights, with their names and numbers overprinted in red to correspond to their designations in the Light List published by the U. S. Coast Guard; and the topography of the area, with 5-foot contour intervals and elevations referred to mean Gulf level at Biloxi, Miss.; but no soundings are shown. In addition, the detail maps contain such features as chutes, creeks, bayous, old river lakes, and mouths of tributaries; railroads, highways, and roads; principal cities, towns, and landings; latitude, longitude, and section lines and numbers; state, county, and parish lines; islands and sand bars; existing levees, bank protection and contraction works, and other flood control and navigation works; river gages and bulletin boards showing river stages; submarine and aerial crossings; transmission and pipelines; bridges; river terminals; ferry crossings; bench marks; and other similar data.

The supplemental sheets contain outline and profile maps; a tabulation of bar crossings; sketches and plans of bridges and locks; an index of principal cities and towns along the river; a tabulation of distances between points on the river; an alphabetical index giving mileage to points along the river and to various geographical locations; a map index giving 10-mile river distances; and a tabulation of project channel dimensions of navigable streams in the Lower Mississippi Valley Division.

The maps are black-line photo-offset reproductions with base map and general information in black, and the water areas overprinted in blue. The complete set is priced at 75 cents and may be obtained by money order or certified check from the Mississippi River Commission, Corps of Engineers, P. O. Box 80, Vicksburg, Miss. Individual sheets are not available.

Roller-Mounted Maps Expedite Position Finding

TWO new air position devices utilizing rolled charts have been developed—one by an American inventor, intended to make personal-flying avigation easier; and the other, made in Britain, designed to give airliner passengers constant visual evidence of their plane's location.

The private flyer's avigational aid, devised by Frank J. Walters of Washington, D. C., is a compact chart holder consisting of a Plexiglas frame so devised that it fits the upper contour of the pilot's leg. (*See* fig. 1.) At each end of the transparent face is positioned a roller to which a standard aero chart may be attached. A mileage scale and a central position indicator are inscribed on the transparency's upper face.

Once the chart has been folded to cover the proposed flight route, it can be attached to the rollers by means of clips, thus providing a convenient holder, obviating frequent chart unfolding, folding, and haphazard estimating of mileage and position data.

An indicator instrument designed by Wing Comdr. C. Hole is now being

FIGURE 1.—Walters' avigation aid.

Reprinted through the courtesy of *Aviation* Magazine, July 1946.

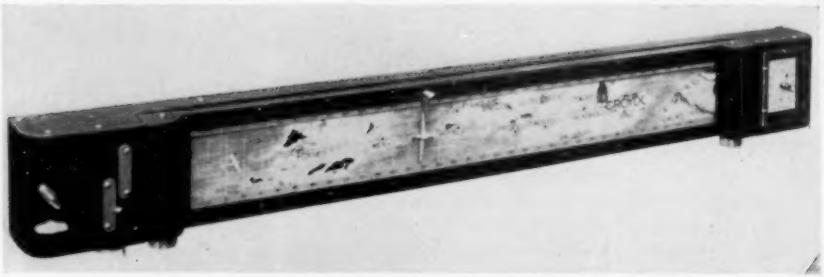

FIGURE 2.—Hole's air position indicator.

manufactured by Redwing, Ltd., of London. (*See* fig. 2.) This device, stated to be entirely self-contained, has no external wiring. There are two models, one 5 feet long, 6 inches deep, and 3 inches wide; the other 3 feet long, 6 inches deep, and 3 inches wide. The larger version weighs about 15 pounds.

The instrument contains a strip map revealing about 600 miles at a time, and over this map travels a model airplane, which can be synchronized with the airliner's speed within a 100-to-400-mph range. Maps are stowed on two spools and may cover up to 8000 miles on a 1/20th scale. A clock is installed giving estimated time of arrival, and maps are marked with plus or minus time variations, relating to standard time or time of the country of departure.

Thus, with the indicator installed in the cabin in full view, passengers are able to keep informed, up-to-the-minute, as to where the airplane is, a particular advantage if the craft is flying above overcast.

The device has been given the name "FRED," connoting Flight Route Easily Determined.

* * *

New Cartographic Camera

A NEW CARTOGRAPHIC CAMERA, manufactured by Fairchild Camera & Instrument Corporation, is designed to provide aerial photographs of rigid precision.

Of simple, compact design, this new unit meets precision camera specifications of the U. S. Department of Agriculture and the U. S. Geological Survey. Its focal length, field of view, negative size, construction, tolerances, and other specifications are such as to permit ready employment of its negatives in the multiplex projector and other stereoscopic plotting instruments.

The Cartographic Camera has several original features. The instrument, which may be operated either automatically or semi-automatically, has two cones, lying one within the other. The inner cone—the optical heart—contains the focal plane and the optical system, and is readily removable as a complete unit for calibration by the U. S. Bureau of Standards as part of Fairchild production procedure. The outer cone contains all operating mechanisms, readily accessible for ease in servicing. Front and rear lens elements may be removed for cleaning and inspection without disturbing collimating, as dowels are provided as an index for accurate alignment when the lens is replaced.

The camera takes 9-inch by 9-inch photographs.—*Civil Engineering*, August 1947.

Surveying and Mapping News

Members are requested to send in surveying and mapping news items for publication in SURVEYING AND MAPPING.—EDITOR.

CURRENT SURVEYING AND MAPPING LITERATURE

MAGAZINE ARTICLES

WORLD REFERENCE ATLASES; A SURVEY OF CURRENT RESOURCES. Walter W. Ristow (Editor), *Bulletin of the American Society for Professional Geographers,* September–October 1945.

THE FIGURE OF THE EARTH. A. H. Miller, *Journal of the Royal Astronomical Society of Canada,* April 1946.

ECCENTRIC REDUCTIONS BY MEANING. J. F. Lincey, *The South African Survey Journal,* June 1946. (A method of reducing to center which enables observations to be taken eccentrically without necessity of subsequent computations.)

NIGHT OBSERVATIONS IN EAST AFRICA. G. E. Marriott, *The South African Survey Journal,* June 1946. (Electric lamps used successfully for night observations to provide control for mapping in East Africa.)

CONVERSION OF COORDINATES IN THE CAPE PENINSULA. G. H. Menzies, *The South African Survey Journal,* June 1946. (How coordinates on the Cassini-Soldner projection were converted to the Gauss conformal projection.)

A MANUSCRIPT ATLAS BY BATTISTA AGNESE IN THE SOCIETY'S COLLECTION. G. R. Crone, *The Geographical Journal* (London), July–September 1946. (Describes a manuscript portolan atlas dated approximately 1550.)

THE PRESENT POSITION OF MAPPING IN AUSTRALIA. *The Australian Geographer,* November 1946. (A review of Australian surveying and mapping.)

HISTORICAL MAPS AND SEAPOWER. Carl G. Gustavson, *The Journal of Geography,* November 1946.

A METHOD FOR PRODUCING SHADED RELIEF FROM AREAL SLOPE DATA. Arthur H. Robinson, *Annals of the Association of American Geographers,* December 1946. (Discusses desirability of producing numerically legible shaded relief from areal slope data.)

THE NEW MEANING OF GEOGRAPHY IN WORLD EDUCATION. Wallace W. Atwood, *The Journal of Geography,* January 1947.

OIL POSSIBILITIES ON THE GULF COAST CONTINENTAL SHELF. *The Oil Weekly,* January 6, 1947.

REFRACTION OF OCEAN WAVES: A PROCESS LINKING UNDERWATER TOPOGRAPHY TO BEACH EROSION. Walter H. Munk and Melvin A. Traylor, *The Journal of Geology*, January 1947.

CURRENT PROBLEMS IN CANADIAN GEOGRAPHIC NOMENCLATURE. G. F. Delaney, *The Canadian Surveyor*, January 1947. (Problems and policies of the Geographic Board of Canada and the surveyor's part in the selection of place names.)

AERIAL SURVEYING ON THE ALASKA HIGHWAY. William T. Pryor, *Public Roads*, January–February–March 1947. (Describes the use of aerial photographs in overcoming difficulties encountered in locating the highway in a region almost devoid of maps.)

TOPOGRAPHY OF THE GULF OF MAINE. Harold W. Murray, *Bulletin of the Geological Society of America*, February 1947. (An analysis of submarine topography of the Gulf of Maine based on surveys performed by the U. S. Coast and Geodetic Survey in 1940.)

AERIAL PHOTOGRAPHS IN STRUCTURAL MAPPING OF SEDIMENTARY FORMATIONS. L. E. Nugent, Jr., *American Association of Petroleum Geologists*, March 1947.

CLOTH MAPS AND CHARTS. Albert A. Stanley, *The Military Engineer*, March 1947. (Brief discussion of cloth maps and charts produced during World War II.)

AIR SURVEY—THE MODERN ASPECT. C. A. Hart, *The Geographical Journal* (London), April 1947. (A discussion of photogrammetric mapping, with emphasis on the British approach and modern developments.)

THE ODOGRAPH. Harry E. Ickes and Thomas L. Cannon, *The Military Engineer*, May 1947. (A description of the instrument for automatically plotting the course of a moving vehicle.)

PHOTOGEOLOGY AIDS NAVAL PETROLEUM EXPLORATION. Norman C. Smith and Sherman A. Wengerd, *American Association of Petroleum Geologists*, May 1947.

ACTIVITIES OF THE U. S. GEOLOGICAL SURVEY IN TEXAS. W. E. Wrather, *The Texas Geographic Magazine*, Spring 1947.

BOUNDARIES OF TEXAS. *The Texas Geographic Magazine*, Spring 1947. (An historical account reprinted from Bulletin 817 of the U. S. Geological Survey.)

THE SOCIETY'S NEW MAP OF CANADA, ALASKA AND GREENLAND. Wellman Chamberlin, *National Geographic Magazine*, June 1947. (Describes map based on wealth of new data from aerial photographs. A new projection is used, the Chamberlin Trimetric, which gives smaller scale differences than the older ones.)

AZIMUTHAL EQUIDISTANT PROJECTION OF THE WORLD CENTERED ON LONDON. Norman Pye, *Geography*, June 1947. (A discussion of two new charts, the Air Age Map of the World and Admiralty Chart No. 5085, and of the projection used.)

ADVENTURES WITH THE SURVEY NAVY. Irving Johnson, *National Geographic Magazine*, July 1947. (A popular account of the activities of the U. S. S. *Sumner* in preparing navigation charts of Pacific Islands under war conditions.)

PLASTIC RELIEF MODELS. Albert A. Stanley, *The Military Engineer,* July 1947. (Describes the methods of producing plastic relief models and their uses.)

STATUS OF TOPOGRAPHIC MAPPING. William E. Davies, *The Military Engineer,* July 1947. (Discusses the status of topographic mapping of the various countries.)

COMPILING MEDIUM AND SMALL SCALE MAPS. Paul Alexander, *The Military Engineer,* July 1947. (Discusses map compilation of the 1:250,000 and 1:1,000,000 series of the Army Map Service.)

AID TO PLANE-TABLE MAPPING. Hobart E. Stocking, *American Association of Petroleum Geologists,* August 1947. (An elementary discussion on how to keep notes and plot points when using a telescopic alidade with Beaman stadia arc.)

AERONAUTICAL CHART SERVICE. T. B. Cantrell, *The Military Engineer,* August 1947. (A description of this Service and of the basic chart series it produces.)

BOOKS AND PAMPHLETS

SUMMARY DESCRIPTION OF EXISTING MAPPING SYSTEMS IN UNITED STATES (OSRD Report 4707). O. M. Miller and Robert Singleton. *National Defense Research Committee,* Washington, D. C. May 4, 1945.

SYSTEM FOR MAPPING FROM HIGH OBLIQUE AERIAL PHOTOGRAPHS (OSRD Report 4714). Robert Singleton, Philip Kissam, and O. M. Miller. *National Defense Research Committee,* Washington, D. C. June 18, 1945.

LAND TITLE ORIGINS; A TALE OF FORCE AND FRAUD. Alfred N. Chandler. *Robert Schalkenbach Foundation,* New York. 1945. 550 pages.

MAP PROJECTIONS. G. P. Kellaway. *Methuen,* London. 1946. 128 pages. (Gives properties, limitations, uses, and method of construction of nearly all known projections.)

GEOGRAPHY FOR GROWN-UPS. Harold Augustin Calahan. *Harper & Bros.,* New York. 1946. 351 pages. $3.50. (A scientific approach which argues that geography is not necessarily a grade-school subject.)

SCIENTIFIC INSTRUMENTS. Herbert J. Cooper, Editor. *Chemical Publishing Co.,* Brooklyn, New York. 1946. 304 pages. $6.00. (Contributions from 15 authorities dealing with optical instruments, measuring instruments, navigational and surveying instruments, and liquid testing instruments. A miscellaneous section deals with acoustical instruments, calculating machines, hardness indicators, and thermionic valves.)

HISTORY OF AIR NAVIGATION. Arthur J. Hughes. *George Allen & Unwin,* London. 1946. 154 pages. 10s. 6d. (Gives history of ancient navigation, development of aviation from 1918 to 1935, and several chapters dealing with compasses, sextants, drift, and radio.)

CONSTRUCTION OF MAP PROJECTIONS. H. A. Hoffmeister. *McKnight & McKnight,* Bloomington, Ill. 72 cents. (Pamphlet discussing projections, drafting, reproduction, etc., designed for use in semester cartography course.)

THE ROUND EARTH ON FLAT PAPER. Wellman Chamberlin. *National Geographic Society,* Washington, D. C. 1947. 126 pages. $0.50. (Described elsewhere in this issue.)

SURVEYING INSTRUMENTS AND METHODS. Philip Kissam. *McGraw-Hill Book Co.,* New York. 384 pages. $3.50.

THE ELECTRONIC ENGINEERING MASTER INDEX. Edited by Frank A. Petraglia. *The Macmillan Company,* New York. 209 pages. $6.00. (Master index to electronics literature which appeared in engineering and allied periodicals from 1935 to 1945.)

SURVEYING: THEORY AND PRACTICE. J. C. Tracy. *John Wiley & Sons, Inc.,* New York. 1,280 pages. $7.50. (Exhaustive treatise on all phases of surveying; new material includes short chapter on aerial photographic surveys.)

ATLAS OF WORLD AFFAIRS. Clifford H. MacFadden, Henry Madison Kendall, and George F. Deasy. *Thomas Y. Crowell Company,* New York. 188 pages (10¾ by 10¾ inches). $2.75. (Specially prepared maps of various parts of the world with geographical and historical text.)

FUNDAMENTALS OF EARTH SCIENCE. Henry Dewey Thompson. *D. Appleton-Century Co.,* New York. 1947. 461 pages. $3.75. (One-semester college survey text including elementary discussion of cartography, meteorology, climatology, mineralogy, petrology, and historical geology; emphasis is on physical geology such as weathering, igneous activity, structural deformation, earthquakes, etc.)

GERMAN RESEARCH IN WORLD WAR II. Leslie E. Simon. *John Wiley & Sons, Inc.,* New York. 220 pages. $4.00 (A summary on German developments. Of particular interest is the development of measuring techniques.)

STORAGE OF MICROFILMS, SHEET FILMS, AND PRINTS. *Eastman Kodak Company,* Rochester, New York. 16 pages. (Furnished free on request.)

BOOKS RECEIVED

AIR-LINE DISTANCES BETWEEN CITIES IN THE UNITED STATES (Special Publication No. 238, U. S. Coast and Geodetic Survey.) C. A. Whitten. *U. S. Government Printing Office,* Washington, D. C. 1947. 246 pages. $1.75. (Described elsewhere in this issue.)

DISTINCTIVE RECENT MAPS

Histories of important surveying and cartographic organizations are always useful, and two such reports have recently been issued. One covers the development of the Service Géographique de l'Armée and its successor, the Institut Géographique National; the other, the Survey of India.

There are two parts to the French report, (1) "Le Service Géographique de l'Armée—son historie, son organisation, ses travaux," Paris, 1938; (2) "Rapport sur l'activité de l'Institut Géographique National de 1940 a 1942," Paris, 1945. The first report, copiously illustrated with maps and photographs, covers the history of the former Service Géographique de l'Armée, from its inception in 1887, with an analysis of cartographic work done by its predecessor, the "Dépot de la Guerre." Following the armistice between France and

Germany in 1940, the Service Géographique de l'Armée, part of the Ministére de la Guerre, was ordered suspended, and the Institut Géographique National was created in its place, as part of the Ministére des Travaux Publics, and now continues with the program of mapping France and other parts of the world. Twenty-five plates accompany the I. G. N. report, showing triangulation and the series of maps issued. There was also issued a "Catalogue des cartes publiées par l'Institut Géographique National—premier fascicult, Cartes de France et publications diverses," January 1943, which gives detail information concerning the maps covering France as to price and extent of surveys. Part 2 of this catalogue has not yet been revised, the last edition being issued in 1939 by the Service Géographique de l'Armée, "Cartes de l'Afrique du nird, du Levant, des Colonies francaises et de divers pays étrangers." In connection with the above reports, attention is drawn to an earlier report issued by the Service Géographique de l'Armée (1931), "La carte de l'Empire colonial francais," which gives an account of the surveying activities in the French colonies.

The report by the Survey of India is the first of a series of volumes entitled "Historical Records of the Survey of India," collected and compiled by Colonel R. H. Phillimore, formerly of the Survey of India. Volume I, published in 1945, covers the 18th century, and describes in great detail the early days of adventure and exploration in India, with full accounts of the work of the pioneer surveyors and geographers. There are many reproductions of portions of early maps, and a very complete set of biographical notes. The second volume will cover the important period from 1800 to 1815, when the foundation was laid of the trigonometrical survey, and order and system were established, while a third volume (1815–1850) will tell of the co-ordination of all the surveys under one Surveyor General, the development of the trigonometrical survey and the start of the great Atlas of India.

The Department of State in Washington has issued a report on the "Treaties of Peace with Italy, Bulgaria, Hungary, Roumania, and Finland (English versions)," (Publication 2743, European series 21, 1947). The first chapter on Italy is accompanied by a series of 23 maps, showing the new frontiers between Italy and the neighboring countries of France, Yugoslavia, and Trieste, together with the status of sea areas in the Adriatic. There are 5 general maps, and the remaining 18 maps are portions of French and Italian surveys on the scale of 1: 20,000, with the new boundaries marked in red.

Thirty-nine maps of France have been received, "Carte industrielles E.G.P. par profession," part of a series of industrial maps published by the Société d'Editions Géographiques Professionnelles, Paris. Printed by Pierre Guieu in Paris, they date from 1939 to 1946 and consist of a map for each industry or profession in France, the various industrial establishments and the nature of their production being listed on the back of each sheet. Scale is approximately 1: 1,600,000, and the cartography is crude, but the maps are useful and informative as they give a unique survey of the industries of France.

The State Economic Planning Authority of Tasmania has issued a regional planning report, "Economic Resources of Tasmania," Hobart, 1945. There are 24 maps, drawn and reproduced by the Department of Lands and Surveys, Mapping Branch, each on the scale of 1 inch to 16 miles, and bound as a folio, with a brief explanatory text to each map. The maps show topography and rainfall, soil types, geology, land use, population distribution, public utilities, transportation facilities, and agricultural, mineral, and industrial resources. This is a very illuminating and carefully prepared study.

A similar report covering the State of Victoria in Australia is published by the State Regional Boundaries Committee, Melbourne, 1944, "Report on Regional Boundaries." The Committee was appointed in April 1944 to "make enquiries and to submit recommendations as to the regional boundaries which might be adopted within the state" in refer-

ence to planning future development of the State in its relation not only to state and national planning, but to local and regional planning as well. This is part of the general plan calling for regional planning studies for all of Australia, including Tasmania, which was instituted in 1944 at the Premiers' Conference in Canberra. The maps in this study of Victoria form an economic atlas consisting of 32 maps and 40 pages of text, bound as a folio. The maps cover the same range of subjects as appear in the Tasmanian report, with the addition of 4 maps on plate 31 showing status of geologic and topographic mapping, and areas covered by air photographs. The majority of the maps are on a scale of 1 inch to 32 miles.

—JOHN K. WRIGHT

"A MANUAL OF COORDINATES FOR PLACES IN MARYLAND"

A NEW STEP in the use of state plane coordinates has been taken by Maryland through the issuing of an index of all geographic names appearing on all commonly available maps of the State or parts thereof. This booklet, entitled "A Manual of Coordinates for Places in Maryland," gives the locations of 14,000 places in terms of state coordinates expressed to the nearest thousand feet. In this way any point in the State may be defined within a tolerance of 707 feet by only seven digits, four for the X coordinate and three for the Y.

The work of compilation was begun by the Maryland State Police during the war, but has since been extended to the point where the State Planning Commission felt that it could undertake the reproduction of the original card catalog in the form of a handy pocket manual for use in the field.

Although intended primarily for police and official use within the State, copies are offered for sale to the public; and it is expected that this book will find a wide variety of uses outside of locating that bothersome little place so small that only the very largest maps show it. This compact listing emphasizes the dangers of confusion between duplicate, or similar, names even within the same county, and thus guards against the misunderstandings that arise. Rough estimates can readily be made of the approximate air-line distances between places by simply taking the greater differences in X or Y coordinates and adding 1/5. The result will be within 20 percent of the correct distance which, of course, could be computed exactly by taking the square root of the sums of the squares of the X and Y differences.

The practicability of the use of approximate plane coordinates, that is to say exact coordinates rounded to the nearest thousand feet, for place identification has already been amply demonstrated by the use made by the Maryland State Police. Already some law evaders have found to their chagrin that the police have a new means of directing their activities more effectively.

It is hoped that through the more widespread use of coordinates, citizens will develop a greater appreciation of their value and will give more wholehearted support to the efforts of engineers to secure their universal use.

—C. F. MERRIAM

NATURAL FUNCTION TABLES

The Coast and Geodetic Survey has recently prepared "Natural Function Tables for Computing Geographic Positions on the International Ellipsoid." The tables are for use with calculating machines. Illustrative examples are given showing the use of the tables for position computations in the Southern Hemisphere. The publication is referred to as G-58 and may be obtained on request from the Director, U. S. Coast and Geodetic Survey, Washington 25, D. C.

Books in Review

SURVEYING. Harry Bouchard. *International Textbook Company*, Scranton, Pennsylvania. Third Edition. 1947. 647 pages. $4.50.

Reviewed by W. N. Brown, Civil Engineer, Washington, D. C.

This is a textbook designed for college students. It has a direct and pleasing style and is very logical in sequence of topics. Beginning with simple types of measurements, the student is conducted through the various survey operations including triangulation and astronomic observations. The final topic is the State Coordinate Systems. At the conclusion of each subject, field and class room problems are given to fix the subject matter in the student's memory. The chapter on Planetable Surveying is treated quite fully and clearly, more so than in many textbooks.

Present-day surveying covers a wide and varied field. Survey methods and instruments are continually changing. Complete treatment in 647 pages is not to be expected; curtailment must be made to suit the limited time allotted by most colleges to the subject. There are some topics and procedures not covered in this text which would contribute materially to the student's success when he becomes a practitioner. Among these are suggested:

(a) Coordinate systems of reference. Discussion of advantages in the simplification of curvilinear and other types of survey computations and in field layout procedure.

(b) Monumentation, especially of property and control surveys. It is to the client's interest and is helpful to the surveyor's reputation if the survey is made permanent by proper monumentation.

(c) Standardization in the use of "azimuth." In federal practice, azimuth is measured from the south; in this book and in much private practice it is measured from the north. This causes doubt, confusion, and error.

(d) Closure error. Texts on surveying should make it clear that in a traverse or a survey closing upon itself, the closure error is not a measure of the accuracy of the survey but is only a measure of uniformity of procedure, whether the method used is good or bad.

THE PRINCIPLES AND PRACTICE OF SURVEYING. Volume II: Higher Surveying. Charles B. Breed and George L. Hosmer. *John Wiley & Sons, Inc.*, New York—*Chapman Hall Ltd.*, London. Sixth Edition. 1947. 690 pages. $4.50.

Reviewed by W. N. Brown, Civil Engineer, Washington, D. C.

This is a 1947 revision of a well-known book on surveying that has stood the test of 39 years' use as a textbook at Massachusetts Institute of Technology. "Higher Surveying" deals with precision survey methods essential to the surveying and mapping of large areas. Much of this can be applied to the procedure in surveys of small areas and if so applied would result in better surveys.

The chapters on Triangulation; Astronomical Observation; and Precise, Trigonometric, and Barometric Leveling have been revised to cover the best current practice. The section on Photogrammetric Surveying comprises 150 pages and is devoted to detailed descriptions and illustrations of various stereoscopic plotting machines, and to a general discussion of aerial photographs and the laws governing the errors due to distortion and displacement and how these may be rectified. The treatment gives sufficient information to enable an engineer, if he has imagination and ingenuity, to advantageously use aerial photography on much of his survey work, even though he does not possess the special and

costly stereoscopic platting instruments. While the text does not attempt to be a complete treatise on photogrammetry, it is sufficient to put the student on notice that aerial photography is a valuable tool at the disposal of the surveyor. Those who plan to engage in large area mapping will realize that they should take a course in photogrammetry.

Topographic engineers familiar with current procedure in topographic mapping with the planetable will agree that the section on "Filling in Topographic Details" should be revised. It gives the impression that the planetable is for use only in open country where extensive areas may be sketched from one station. Experience shows that in wooded areas the planetable is more flexible than the transit. The planetable operator can take advantage of the numerous small openings, wiggling his planetable traverse here and there, plotting his position as he goes so that he always knows just where he is and just where he needs additional rods to fill out the map, thus keeping brush cutting to a minimum. It is also stated that one of the advantages of the transit-stadia method of filling in map detail is that the control (traverse and triangulation) may be surveyed after the detailed survey. While this might possibly be done, experience has shown time and again that there is no surer way of causing confusion and error in the platting of the detail survey field notes, with consequent additional field work and waste of time in straightening out the errors.

Planning is more and more becoming the province of the engineer. Planning has now gone beyond city and state planning and is assuming continental and even world-wide proportions. This volume will be found of value to every engineer who desires to take part in making the extensive surveys needed for such planning.

* * *

A NEW MANUAL OF SURVEYING INSTRUCTIONS

OF INTEREST to land surveyors is the 1947 Manual of Instructions for the Survey of the Public Lands of the United States, recently published by the Bureau of Land Management (formerly the General Land Office) of the Department of the Interior.

This is the seventh of such manuals, the six previous ones having been issued in the years 1855, 1881, 1890, 1894, 1902, and 1930. The new manual, like its predecessors, describes the latest methods and procedures for the survey of the public lands. Chapters are included on Instruments and Methods, System of Rectangular Surveys, Corner Monuments, Restoration of Lost Corners, Resurveys, Special Surveys and Instructions, Field Notes, Plats, and Mineral Surveys. A brief history of the laws and regulations applying to the Public Domain, covering such subjects as title, navigable waters, swamp and overflowed lands, early laws and more recent legislation, and general surveying rules, is also included.

The manual contains 613 pages and is sold at $2.50 by the Superintendent of Documents, *U. S. Government Printing Office,* Washington 25, D. C. Remittance should be made by certified check or postal money order.

—W. S. DIX

"THE ROUND EARTH ON FLAT PAPER"

IN CONNECTION with the review of Elements of Map Projection, which appeared in the January–March 1946 issue of SURVEYING AND MAPPING, I wish to call attention to a map monograph which has just been issued. This publication of the National Geographic Society, entitled "The Round Earth on Flat Paper," contains an excellent popular description of map projections in general use by cartographers. More than 60 pages are devoted to a discussion of the various projections. The illustrations are rendered in striking graphic analyses which make the fundamental principles of the projections readily apparent.

Since relatively little has been published in the "semi-technical" field of map projection, this monograph is recommended to all who wish to understand the basic natures of the various systems by easy dosage. Other articles regarding map compilation and the several map series published by the National Geographic Society are contained in this monograph which may be purchased from the Society for 50 cents.

—C. F. FUECHSEL

TABLE OF AIR-LINE DISTANCES PUBLISHED

THE U. S. Coast and Geodetic Survey has recently published an extensive table of air-line distances between cities in the United States. The list includes 392 cities which are authorized points of certificated air routes of domestic air carriers, plus 100 additional cities which were added in anticipation of future needs.

The publication was prepared to meet an increasing number of requests for accurate air-line distances computed on the earth's surface, treating the earth as an ellipsoid of reference with proper mathematical dimensions. The method of computation is explained in the Appendix of the publication with numerical examples and fundamental tables for making computations between cities not included in the published list.

A list of the geographic positions of reference points in the cities is also given in the Appendix. Generally, the reference point for a city is the intersection of the two principal streets or, in the case of larger cities, the intersection of streets nearest the main post office.

The problem of computing distances between 492 points involved more than 120,000 computations. Actually, almost 250,000 computations were made, since the work was done in duplicate as a check. Procedures were developed for making the computations by punched cards. After the duplicate cards had been compared, and all possible checks made for the purpose of eliminating errors, the tables were printed directly from the cards.

The publication may be purchased from the Superintendent of Documents, *U. S. Government Printing Office,* Washington 25, D. C., as Special Publication No. 238 (U. S. Coast and Geodetic Survey), Air-Line Distances Between Cities in the United States, at a price of $1.75.

—C. A. WHITTEN

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Wire Dictating Machine

SPECIFICALLY designed and built as a dictating machine for general business use, a magnetic-wire recorder, complete in one unit, combines both recorder and play-back. The voice of the speaker is recorded on a strand of stainless steel wire moving between two spools. The same wire passing through the magnetic field with the control switched to the "listen" position reproduces the voice with all the clarity of the original. The spool of wire may be stored away and reproduced years later with no impairment of reproduction, or it may be reused by simply recording over the original message.

One of the features of this machine, called Sound-On-Wire, is forward and rewind speeds of 20 feet per second, ten times faster than the recording speed. This added speed facilitates the whole dictating operation by cutting down the time spent in going back in the message to make "erasures." When a correction is desired, the wire is reeled back at this accelerated speed and the operator simply re-dictates. No intermediate step is required, as the wire is automatically cleared when it passes through a demagnetizer coil before reaching the recording head.

The magazine holding the wire is self-contained and can be transferred from one machine to another for play-back or recording. The controls are so simplified that no instructions are required to operate it.

With the use of a small earphone about the size of a modern hearing-aid ear piece, the transcribing operator can adjust the volume so that the reproduced sound cannot be heard by others in the room. A convenient pedal-type control enables the operator to start and stop playback by applying light foot pressure.

In addition to general office service, Sound-On-Wire, a product of the Standard Business Machine Company, is adapted to many special uses such as recording radio programs, business meetings, and telephone conversation.—*Scientific American,* May 1947.

Lab Camera Develops Photo in Thirty Seconds

IN A MILLIONTH OF A SECOND a photo is taken. Thirty seconds later, the finished photo is projected on a screen. A new rapid-action camera combination for taking and developing pictures was announced by General Electric. Used in studying surges of current on electric power lines, it is a non-portable laboratory device, not for amateur use.

The camera has a speed of one-millionth of a second. Used in combination with a cathode ray oscillograph, the camera photographs what appears on a television-like screen when a surge of electricity is applied to the generator and transmitter equipment under test.

As soon as the photograph is taken, the operator pushes a button setting in action automatic developing equipment which completes its job in 24 seconds. Then the film passes into a projector which shows the negative, enlarged ten times, on a ground-glass screen on one side of the camera.

Several quick taking-developing-viewing cameras have been developed. Eastman Kodak Company produced a system by which a person can be photographed and see his picture on a screen 15 seconds later. Polaroid Corporation developed a process adaptable to small cameras by which finished pictures are obtained in one minute.

More recently, a heavy-weight camera, complete with developing and fixing equipment, which takes a pair of pictures at the same time and has them ready one minute later for viewing with a stereoscopic device was announced by the Kannestine Laboratories of Houston, Texas.—*Science News Letter,* May 24, 1947.

New Drafting Pad

"Jiffy Sketch" is the name of a scale drawing pad introduced by Jiffy Sales Co., Cleveland. It enables one to make properly proportioned drawings without use of ruler, drafting board, or T-square, and it may be used in shop, field, or office.

The Jiffy Sketch pad contains 75 sheets of high quality tracing tissue, enclosed within a cover jacket of four cardboard flaps. Various scales are printed on three of the flaps. To use the pad, you fold back the cover flap and place one of the tissue sheets over the scale you wish to employ. The drawing is made accurately to scale with the aid of the printed lines which show through the tissue.

The pad measures approximately 9 by 12 inches and sheets are perforated for easy removal. Valuable information is printed on the back of each cover flap—basic mechanical drafting standards, electrical, welding, and architectural symbols, decimals of a foot, decimal equivalents of fractions, with circumferences and areas of circles. Jiffy Sales Co., 1804½ East 37th Street, Cleveland 14, Ohio.—*The Nautical Gazette,* March 1947.

Comment and Discussion

The pages of SURVEYING AND MAPPING are open to a free and temperate discussion of all matters pertaining to the interests of the CONGRESS. It is the purpose of this Department to encourage comments on published material or the presentation of new ideas in an informal way. —EDITOR.

LAND SURVEYING A SENIOR OPTION AT PURDUE

Purdue University in Lafayette, Ind., has recently announced a course in land surveying as a senior option. The course is under the guidance of Mr. W. E. Camp, instructor in surveying and a member of the American Congress on Surveying and Mapping.

Mr. Camp has expressed his desire for bulletins, pamphlets, and documents relative to property surveying, for use in this new course, and the Property Surveys Division is doing its utmost to cooperate.

The Property Surveys Division, in its supplemental recommendations under the Technical Standards for Property Surveys, has recommended the formation of such classes, and is happy to see this beginning of what we hope will become a general movement in engineering institutions, for instruction in property surveys, titles, descriptions of land, problems of reestablishment of property lines, etc.

The Property Surveys Division extends its congratulations to Mr. Camp and Purdue University for its new venture.—S. A. BAUER, Chairman, Property Surveys Division.

ON THE SEVENTH ANNUAL MEETING

I want to take this opportunity to express to you our appreciation for the invitation to exhibit at the Seventh Annual Meeting of the Congress, and to congratulate you on the manner in which the exhibit was held. I have attended many such affairs. I believe this was the best one that it has ever been my privilege to see. We also want to thank you for your personal attention and co-operation in making sure that everything went along smoothly.—W. L. EGY, Brunson Instrument Co., in a letter to Ralph M. Berry.

After attending the Seventh Annual Meeting of the Congress, I am very much impressed with the organization and wish to express my gratification in having participated.

When I first joined the Congress I must admit that I was somewhat skeptical since my experience in the past has been that many similar organizations have been more social than technical and more concerned with the political advancement of a few than with the over-all benefit to the profession. I think that the determining factor in my becoming a member was the publication which, I feel, is extremely outstanding and I would like to take this opportunity of congratulating you as Editor in the achievement of a superlative job.—HERBERT HARTMAN, of Clarke & Hartman, Engineers.

CONGRESS NEWS

Secretary's Report

(Abstract of Report Submitted at Annual Meeting, August 15, 1947)

THE Congress membership continues to grow at a rate of one new member per day, for an increase of some 450 new members and reinstated members since the Sixth Annual Meeting. The present considered active mailing list in round numbers totals 1,400, including 114 libraries and institutions, 14 commercial members, 12 exchanges, and 1,360 individual members. Of the latter, approximately 1,000 paid their dues for 1947 before June 30, with some 100 having paid since that date. This leaves about 250 yet unpaid, but payments are being received daily.

The increased membership and other activities of the Congress have added to an already heavy work-load on the volunteer staff who are "carrying the ball" for the Congress. If you will analyze the Treasurer's report, you will see that the annual dollar income just about covers bare essentials. Expenditures do not indicate the time and effort of the officers and committeemen and their organizations, or the operational functions required to accomplish so much work.

A few of the more important matters of business occurring during the past year are briefly summarized below:

Immediately after the Sixth Annual Meeting in June 1946, the full attention of the Secretary's office was focused on renovating the membership mailing-plate files. Many addresses were completely out of date, as a result of frequent moves of returning service men, the frequent shifting about due to housing conditions—all in addition to the normal shifting of field personnel. This project required many man-hours.

President Borden and his staff and committees concentrated on studying ways and means to revise the Constitution, to disperse the work-load on the Editor of SURVEYING AND MAPPING, to maintain active membership drives, and to get SURVEYING AND MAPPING published and delivered to the membership. It was noticeable that a steady rise in printing and other costs was taking place, hence serious consideration had to be given to means of increasing revenue.

On November 25, 1946, President Borden advised that he had been ordered to active sea duty. Vice President Marshall S. Wright, of Region 2, was called upon to serve as Acting President for the remainder of the term.

At the suggestion of the American Society for Engineering Education, the Congress agreed to act as co-sponsor for annual state surveying and mapping conferences. Professor Harding, Ohio State University, serving as chairman for the ASEE committee, agreed to serve also as chairman of the Congress's committee for this purpose. The other representatives from the Congress are: Messrs. Aiken, Barclay, Black, Bouchard, Dodds, Haines, Mirgain, Park, Rayner, Sharp, Shea, Steinberg, and Welch.

In January 1947, Mr. J. O. Kilmartin, of the Map Information Office of the U. S. Geological Survey, was appointed chairman of the Publications Committee. The Congress's Executive Committee approved the charter for and authorized the establishment of the Washington, D. C. section of the American Congress on Surveying and Mapping. Captain C. L. Garner, Coast and Geodetic Survey, resigned as chairman of the Technical Division on Control Surveys. New officers of the Control Surveys Division, elected by letter ballot, are: Chairman, Commander H. W. Hemple, Coast and Geodetic Survey; Vice Chairman, Prof. O. J. Marshall, Ohio State University; Secretary-Treasurer, Mr. Floyd W. Hough, Army Map Service; Associate Editor, Mr. R. M. Wilson, Geological Survey.

Mr. Albert Nowicki, of Army Map Service, was appointed chairman of the Membership Committee in February.

Reprints of the technical Standards for Property Surveys were given wide distribution to universities and other interested organizations.

Ballots for the election of President and for revision of the Constitution were prepared and sent to the membership. A Prize Contest Committee was named, with Professor George H. Harding as chairman, and cash awards of $100 and $50 authorized for the two best articles submitted for SURVEYING AND MAPPING during 1947.

Respectfully submitted,

W. S. DIX,
Acting Executive Secretary

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Reports of Technical Divisions and Committees

(As Presented at Seventh Annual Meeting, August 15, 1947)

PROPERTY SURVEYS DIVISION

The Division concerned itself primarily with the distribution of the newly adopted Technical Standards for Property Surveys, and the encouragement of their adoption by various technical organizations. A considerable number of the Standards have been distributed through the various officers and chairmen of the Division; systematic distribution and promotion of the Standards are in the hands of Ralph M. Berry, membership chairman of the Division. Adoption of the Standards among national groups is being promoted by the officers of the Congress. The Standards have met with considerable praise from those among whom they have been circulated.

The new activity begun during this past year was the formation of a committee, under the chairmanship of Ford Bartlett of New York City, for the purpose of studying surveying fees, with the hope of developing some sort of report that will be helpful to the profession throughout the country in determining proper methods of charge for professional services. This activity is a first step toward establishing a uniformity of professional thought and practice in this regard.

Your chairman is pleased to report that there are evidences of increasing recognition of the leadership in surveying fields on the part of the Congress, as evi-

denced by various inquiries pertaining to surveying matters. One of the greatest benefits that can be rendered by the Congress is that of fountainhead for all matters of surveying; and one of the surest indications of the health of the Congress is the extent to which professional problems are brought to it for solution.

The Division is attempting also to supplement its new Standards with what might be termed "Canons of Practice," which would consist of considered opinions on the part of the profession on specific details arising from the practice of the profession.

Your chairman wishes to thank his officers and committee chairmen and the officers and members of the Congress for the support they have given him.

S. A. BAUER, *Chairman*

CONTROL SURVEYS DIVISION

The functions of the Control Surveys Division are to study, report on, and make recommendations to the Congress on any matters concerned with control surveys. During the past year nothing has been presented to the Division requiring action, nor has the Division itself made any studies which should be reported on.

We are aware of the work being accomplished in connection with electronic methods of distance determination. Such matters will be reported on when their feasibility and adaptability for ordinary survey practice is apparent.

A significant survey accomplishment during the past year was the completion of the urban control for the East Bay area of San Francisco Bay, California. Eleven organizations, including counties, cities, and public utilities, co-operated on this project. The Coast and Geodetic Survey contributed supervisory personnel, instrumental equipment, and portable steel triangulation towers, and will compute and adjust the field observations. (An article describing this project appears elsewhere in this issue.) At the present time a similar co-operative urban control survey project is underway in Cincinnati, Ohio.

During the year the Coast and Geodetic Survey has issued sketches of first- and second-order triangulation and leveling, respectively, for each state on an approximate scale of 1 : 650,000. Descriptions of these are given in the January–June 1947 issue of SURVEYING AND MAPPING. Publications concerned with control surveys either in press or published during the year include the Coast and Geodetic Survey Special Publication No. 237, "Manual of Geodetic Astronomy," and Coast and Geodetic Survey Special Publication No. 239, "Manual of Geodetic Leveling." The first-named publication is concerned with field methods of precise astronomic determination in connection with geodetic control; the second is concerned with field methods for first- and second-order leveling and will be followed at a later date by a companion publication concerned with the computational methods for geodetic leveling.

The arrangements with the Latin American countries through the Cooperation with American Republics Program of the State Department have continued in effect throughout the year, and citizens of the various American Republics have been given training in various phases of surveying and mapping procedure in this country. This program has been in effect for 7 years and has been a distinct contributing factor to the establishment of the Good Neighbor Policy with our sister republics.

H. W. HEMPLE, *Chairman*

COMMITTEE ON REVISION OF THE CONSTITUTION

The Committee on Revision of the Constitution was given the task of studying, analyzing, and revising the Constitution with a view to strengthening the organizational structure of the Congress. In considering the problem the Committee rewrote portions of the Constitution looking toward: (1) Organizing a Board of Direction larger and more representative of the numerous and varied fields of interest than the old Constitution called for; (2) enlarging the Executive Committee so that the increasing administrative duties could be more widely delegated and remove some of the heavy load which individual officers have been carrying; (3) changing the Regional structure to an Advisory Council which it is hoped will bring the Congress stronger national support and interest; (4) strengthening the headquarters organization with additional officers to divide responsibility and to make the carry-over of duties due to changes caused by annual elections easier and more efficient; and (5) increasing the dues.

In its effort to revise the Constitution the Committee was in constant touch and frequent consultation with members of the Executive Committee and is deeply appreciative of the constructive counsel and aid which it received.

HELMUTH BAY, *Chairman*

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Fall Meeting, Washington Local Section

THE 1947 fall meeting of the Washington Section, American Congress on Surveying and Mapping, was held in the Department of Commerce Auditorium on October 27, 1947. The meeting was opened by Mr. Robert L. Moravetz, Vice-Chairman, acting for Chairman Daniel Kennedy. Routine matters of interest to the local section were discussed during a brief business session.

The Coast and Geodetic Survey conducted the technical program for the evening, which included discussions pertaining to the work of the various technical divisions of the Bureau. Rear Admiral J. H. Hawley, Assistant Director of the Survey, gave a brief outline of its organization and background. Papers describing the work of each division were presented by the division chiefs or other designated representatives. These included discussions on tides, Shoran control in hydrographic surveying, geomagnetism, geodetic control surveys, photogrammetric surveys, and the production of nautical and aeronautical charts.

A highlight of the evening was the exhibit of equipment, operations, and products of the Coast and Geodetic Survey. The display was favorably received by the membership and special attention was given to the panel illustrating the method of preparing vinylite proofs. Among the 25 panels comprising the exhibit were several illustrating the recent development of plastic relief models by the Coast and Geodetic Survey. Considerable interest was expressed in the model of northeastern United States combining land and offshore submarine topography.

Mr. Marshall Wright, President of the parent organization, in a brief address, directed attention to the objectives of the Congress and complimented the local section on the expediency with which the program was conducted.

—A. A. STANLEY

Financial Statement

(As of June 30, 1947)

INCOME

Balance on hand (July 1, 1946)	$2,931.27
Memberships (Commercial)	450.00
" (Libraries)	315.35
" (Individual)	4,066.37
Subscriptions	21.00
Sales of back issues	111.34
Donation for Spanish edition	91.86
Donation and miscellaneous sales	18.15
Sixth Annual Meeting	624.69
Sale of Congress emblems	115.50
Dues of Washington Local Section (in trust)	31.00
TOTAL ACCOUNTABLE FUNDS	$8,776.53

EXPENDITURES

Printing—SURVEYING AND MAPPING (Index and 5 issues)	$4,312.30
Miscellaneous printing	338.98
Mailing service	382.15
Office supplies	557.47
Addressographing	114.34
Sixth Annual Meeting	830.21
Congress emblems	351.84
Stenographic service, Banking, P. O. box rent, Travel	80.01
Prize for Congress emblem competition	25.00
TOTAL EXPENDITURES	$6,992.30
Bank balance on July 1, 1947	1,784.23
TOTAL ACCOUNTED FUNDS	$8,776.53

GENERAL BALANCE

Bank balance on July 1, 1947	$1,784.23
Accounts Receivable: Sale of emblems	236.34
Current dues	600.00
New members	300.00
TOTAL ASSETS	$2,920.57
Unpaid Obligations	0.00
NET VALUATION OF CONGRESS	$2,920.57

Respectfully submitted,

RICHARD T. EVANS,
Treasurer.

NEW MEMBERS

ANDERSON, D. D.
Engineer, Division of Waterways,
201 W. Monroe St., Springfield, Ill.

ANDREASSIAN, J. DER
Geology Department, Anglo-Egyptian
Oilfields Ltd., Cairo, Egypt

ATKINSON, ROBERT M.
Civil Engineer,
Box 4093, Houston, Texas

AUSTIN, WILSON
Chief Engineer, Wilson Aerial Surveys,
Box 332, Olean, New York

BACHARACH, ABRAM F.
Surveying Instructor, Balto. Poly. Inst.,
5616 Greenspring Ave., Baltimore, Md.

BAKER, GERALD J.
Assoc. Engr., U. S. Geological Survey,
1314 N. Courthouse Rd., Arlington, Va.

BAKER, WALDO LUCEIN
Bridge Inspector, C. & E. I. R. R.,
200 S. Franklin St., Salem, Ill.

BARKER, JAMES GORDON
Attorney and Consulting Surveyor,
415 N. Main St., Jasper, Texas

BATTEEN, EARL R.
Photogrammetric Engineer, U.S.G.S.,
1211 N. Kennebec St., Arlington, Va.

BEINGOLEA, JOSE F.
Lt. (j.g.), Hydro. Office, Peruvian Navy,
Rm. 314, Hotel Fairfax, Washington, D. C.

BELOTE, EARL S.
Mathematician, U.S.C. & G.S.,
641 Washington St., New York, New York

BERMEL, PETER F.
Student, Missouri School of Mines,
1007 Main St., Rolla, Missouri

BOOTH, GORMAN W.
Surveyor, Party Chief,
1010 S. 6th St., San Jose, California

BOWSER, LEONARD
Land Surveyor, Party Chief,
1300 Schuyler Rd., Beverly Hills, Calif.

BRAMMELL, JAMES A.
Act. Chief, Map Info. Br., State Dept.,
3428 Fairhill Dr. SE., Wash., D. C.

BREED, CHARLES B.
Prof. Emeritus, Civil Engr., M.I.T.,
1–370 M.I.T., Cambridge, Massachusetts

BRIDGES, CLARENCE E.
Topog. Engineer, Corps of Engrs.,
4232 Broadway, Sacramento, California

BROKENSHIRE, JOHN H.
Engr., Survey Section, Corps of Engrs.,
3135 N. E. 29 Ave., Portland, Oregon

BROWN, ART H.
Engineer, Arundel Corporation,
Pier 2, Pratt St., Baltimore, Maryland

BROWN, HOMER
Photogrammetric Engineer,
223 Hammond St., San Antonio, Texas

BUCKEY, CHARLES W.
Topographic Engineer, U.S.G.S.,
1109 N. Highland St., Arlington, Va.

CAPP, MARTIN P.
Chairman, C. E. Dept., Univ. of Denver,
University Park, Denver, Colorado

CARDENAS, ISMAEL RIVERA
Land Surveyor,
2241 35th Ave., San Francisco, Calif.

CARR, L. P.
Engineer, Shell Oil Company,
8019 Hartford St., Houston, Texas

CARRILLO, HUGO
Lt., Serv. Geog. del Ejercito, Mexico,
c/o U.S.C. & G.S., Washington, D. C.

CARROLL, JOHN
Surv. Engr., Bur. Geol. & Topo., #8 Temp.
Bldg., Carling Ave., Ottawa, Canada

CHAPMAN, C. M.
Government Surveyor, Lands, Mines,
and Surveys Dept., Suva, Fiji

CHASE, HEMAN
Surveyor,
Alstead, New Hampshire

CHASE, L. M.
Engineering Aide, U.S.C. & G.S.,
4817 Frohlick Lane, Hyattsville, Md.

CLEARY, J. B.
Engineer and Land Surveyor,
Box 443, Bothell, Washington

CLUTE, HAROLD M.
Civil Engineer, Corps of Engineers,
Box 2056, Kansas City, Missouri

COMER, R. J.
Professional Engineer,
524 N. Cherry Street, Kenton, Ohio

CORNITIUS, LEONARD E.
Head, Maps, Rec. Dept., Houston Light & Power Co., Box 1700, Houston, Texas

CROMWELL, CAMERON
Assoc. Engr., Bureau of Water Supply, City of Baltimore, Sparks, Maryland

CROOK, D. KEN
Chief, Carto. Div., Soil Conserv. Serv., Reg. 5, 3801 Everett St., Lincoln, Nebr.

CUCURULLO, OSCAR, JR.
Ing. Professor, Univ. of Santo Domingo, A. P. 943, Trujillo, Rep. Dominicana

DANIEL, ROBERT L.
Supervising Engineer,
Box 955, Hammond, Louisiana

DAVILA, NARCISCO C.
Head, Engr. Div., P. R. Land Authority, Tenth Street 14, Rio Piedras, P. R.

DE GIACOMA, FRANK
Lt. Col., Engineer Hq., Antilles Dept., APO 851, c/o Postmaster, Miami, Fla.

DORAN, PHILIP C.
Lt. Comdr., U. S. Coast and Geodetic Survey, Washington, D. C.

DOUGHTY, EARNEST H.
Mapping Draftsman,
114 Pine Ave., Wheeling, West Virginia

DOUTHIRT, JOHN F., JR.
Engineer,
621 S. Pulaski St., Baltimore, Md.

DURKIN, JOHN J.
Engr., Res. & Dev. Lab., Ft. Belvoir, 1009 21st St., Arlington, Virginia

DUTIL, J. P.
Assistant Director of Surveys, Dept. of Lands and Forests, Quebec, Canada

DYER, BEN
Civil Engineer and Land Surveyor,
3118 Hamilton St., Hyattsville, Md.

ECKERSON, S. J.
Manager, Comp. Dept., Gen. Draft. Co.,
21 West Street, New York, New York

EGY, R. J.
Engineer, Brunson Instrument Co.,
1405 Walnut Street, Kansas City, Mo.

ELIAS, FERNANDO
Lt. Comdr., Hydro. Off., Peruvian Navy, Ministerio de Marina, Lima, Peru

ETHRIDGE, TOM W.
Field Engineer, Texas Highway Dept.,
1412 6th Street, Galena Park, Texas

FAULKNER, JACK
Asst. Chief, Sur. Sec., U. S. Engineers, Vicksburg, Box 37, Belzoni, Mississippi

FISHER, JAMES R.
Student, Missouri School of Mines,
1007 Main Street, Rolla, Missouri

FLORES, OCTAVIO
Capt., Inst. Geology Militar de Chile, c/o U.S.C. & G.S., Washington, D. C.

FREEMAN, J. D.
Consulting Surveyor,
3001 Bridle Path, Austin, Texas

GAY, HARRY SCOTT
Draftsman, Carbide & Carbon Chem. Corp.,
1702 Honaker Ave., Princeton, W. Va.

GERHOLD, JOHN F.
Geographer, Army Map Service,
6109 Ridge Drive, Brookmont, Maryland

GOGGIN, JOHN P.
Civil Engineer,
P. O. Box 28, Clare, Michigan

GREEN, WILLIAM F.
Field Supervisory Engineer,
3018 Hamilton St., Hyattsville, Md.

GULLA, CARL PAUL
Reg. Supervisor and Contractor,
10809 Woodstock Ave., Cleveland, Ohio

HALL, J. L.
Draftsman, The Ohio Oil Co.,
437 S. Hill St., Los Angeles, Calif.

HALL, M. WILLARD
Owner, M. W. Hall Co.,
105 Forsyth St., Augusta, Georgia

HARTMAN, HERBERT C.
Engr., Land Surveyor, Clarke & Hartman,
30 Journal Square, Jersey City, N. J.

HENRY, JAMES E.
Photogrammetric Engineer,
203 W. Parkwood Drive, Dayton, Ohio

HICKERSON, HOMER C.
Hall and Hickerson, Surveyors,
708 South Barbee Way, Louisvlle, Ky.

HILLBERG, L. J.
Lt. Col., Dept. of Mil. Topo. & Graphics, U. S. Military Academy, West Point, N. Y.

HOLL, RICHARD C.
Photogrammetric Engineer, U.S.H.O.,
513 71st St., Seat Pleasant, Maryland

HOPKINS, PAGE E.
Civil Engineer,
8644 Colesville Road, Silver Spring, Md.

HORTON, GRAYDON T.
Lecturer, U. of Toronto, Ajax Division,
14 Edward Street, Ajax, Ontario, Canada

HUESCA, RUBEN WALLER
Photogrammetrist, Div. de Geografia,
Mexico, c/o U.S.C. & G.S., Wash., D. C.

HUNTER, ROBERT W.
Geod. Comp., Surv. Div., Dept. of Public
Works, 45 Outlook Dr., Lexington, Mass.

HUTCHINSON, JAMES P.
Photogrammetrist, Navy Department,
506 8th St., District Heights, Maryland

IRVING, G. C.
Actg. Dep. Chief Surveyor, Malayan Union
and Singapore, Kuala Lumpur, Malaya

JACKSON, CHARLES DONALD
Ch., Survey & Maps, U. S. Forest Serv.,
63 Sunshine Ave., Sausalito, Calif.

JAMES, M. H., JR.
Civil Engineer and Surveyor,
305 S. Liberty St., Canton, Mississippi

JAMES, M. H., SR.
Civil Engineer and Surveyor,
Sumner, Mississippi

JEPPESEN, MARIUS C.
Registered Land Surveyor,
2811 63rd Place, Cheverly, Maryland

JIMENEZ, ROBERTO
Major, Military Engineer,
Castro 354, Santiago, Chile

JOHNSON, JOSEPH C.
Draftsman, D. C. Engineer Department,
4631 Yuma St., N.W., Washington, D. C.

JOHNSTON, ODIS D.
Geodetic Engineer,
Box 79, Margarita, Canal Zone

KAY, WILLIAM J.
Instructor, Civil Engineer,
Purdue University, LaFayette, Indiana

KELLEY, JOSEPH J.
Field Manager, Aero Service Corp.,
2045 Bleigh St., Philadelphia, Pa.

KEUREN, V. VAN
Head Engineer, U. S. Navy P. I. C.,
4690 Nichols Ave., Washington, D. C.

KEY, JOHN C.
Assistant Professor, Civil Engineer,
The Citadel, Charleston, S. C.

KISER, HENRY A.
Office Engr., Ben Dyer, C.E. & Surveyor,
3018 Hamilton St., Hyattsville, Maryland

KNIGHT, EDMUND C.
Civil Engineer, U. S. Engineers,
P. O. Box 931, Savannah, Georgia

KRAUSE, FRANK B., JR.
Civil Engineer and Surveyor,
Northfield & Louis Roads, Bedford, Ohio

LAMBORN, OLLIE A.
Registered Surveyor,
203½ W. Gold St., Albuquerque, N. Mex.

LEFKOWITZ, HYMAN I.
Land Surveyor,
414 Mission E. Way, Los Angeles, Calif.

LEHMAN, PAUL H.
Cartographic Engr., Hydrographic Office,
6602 Exeter Rd., Bethesda, Maryland

LE TELLIER, L. S.
Head, Dept. of Civil Engineering,
The Citadel, Charleston, S. C.

LEWIS, J. M.
Adams County Engineer,
Natchez, Mississippi

LOCATELLI, DELFO E.
Ingeniero Civil,
25 de Diciembre 1150, Rosario, Argentina

LYON, GEORGE B.
Instructor, C. E. Dept., 123 Engr. Bldg.,
Univ. of Minnesota, Minneapolis, Minn.

MACLEAN, DONALD
Captain, Inst. Geog. Militar de Chile,
c/o U.S.C. & G.S., Washington, D. C.

MAIDLOW, DELBERT K.
Map Draftsman,
Route #1, c/o H. W. Hinse, Wharton, Tex.

MARCHANT, JOHN C.
Lt. Col., Hq., Caribbean Air Command,
Albrook Field, Canal Zone

MARMER, H. A.
Asst. Chief, Div. of Tides and Currents,
U.S.C. & G.S., Washington, D. C.

MARTIN, R. G.
Civil Engineer,
368 N. Canon Dr., Beverly Hills, Calif.

MCALEER, RALPH E.
Cartographer, National Geographic Society,
16th & M St., N.W., Washington, D. C.

MCCALL, JOHN S.
Geodetic Engineer, Army Map Service,
Box 352, Parkers Landing, Pennsylvania

MCCUTCHEN, A. C.
Chief, Photogram. Sec., Central Division,
U.S.G.S., Box 133, Rolla, Missouri

McGIRK, LON S., JR.
Geodetic Engineer, Corps of Engineers,
530 NW. 23rd St., Portland, Oregon

McMILLEN, H. J.
Photogrammetric Engineer,
4311 15th St., North Arlington, Va.

McNAIR, ARTHUR J.
Associate Professor, Civil Engineering,
University of Colorado, Boulder, Colo.

MECHA, RICHARD B.
Surveyor, City Engineers Office,
1231A S. 10th St., Manitowoc, Wis.

MEGA, THOMAS R.
Tte. Cnel., Chief Adjutant, Office of
Inspector General, Montevideo, Uruguay

MEJIA, EDWARDO J.
Civil Engineer,
Banco de Bogota 612, Medellin, Colombia

MESSENGER, A. R.
Civil Engineer,
221 13th St., N.W., Cedar Rapids, Iowa

MEYER, RUDOLPH W.
Chief, Computing Sec., U. S. Engineers,
Vicksburg, Mississippi

MILLER, JOHN V.
Dr., Physician, Amateur Mapper,
P. O. Box 198, Dillsburg, Pennsylvania

MOORE, E. GLENDON
Asst. Photogrammetric Engineer,
1215 N. Courthouse Rd., Arlington, Va.

MOORE, LIONEL C.
Cartographic Editor, U. S. Geological
Survey, Washington, D. C.

MOORHOUSE, WILLIAM H.
Photogrammetric Engineer, A.M.S.,
1820 Clydesdale Pl. N. W., Wash., D. C.

MORALES, RAYMUNDO
Lt., Serv. Geog. del Ejercito, Mexico,
c/o U.S.C. & G.S., Washington, D. C.

MORRISON, LLOYD J.
Highway Engineer, Public Roads,
3274 Grant Avenue, Ogden, Utah

MORSE, E. D.
Civil Engr., Houston Light & Power Co.,
8158 Niles Avenue, Houston, Texas

MULLAN, ROBERT H.
Civil Engineer, 1000 Ross Ave.,
Wilkinsburg, Pittsburgh, Pa.

MUNDHENK, GEORGE
Surveyor, City of Los Angeles,
7623 S. Denker Ave., Los Angeles, Calif.

MUNROE, BENJAMIN, JR.
Photogrammetric Engineer, A.M.S.,
2722 Colston Dr., Chevy Chase, Maryland

NELSON, HERBERT S.
Photogrammetric Engineer, U.S.G.S.,
2621-29th St., S.E., Washington, D. C.

NELSON, LOUIS G.
Mathematician, U.S.C. & G.S.,
641 Washington St., New York, N. Y.

NEMMER, JOHN
Surveyor, Carnegie Illinois Steel Corp.,
409 Overbrook Blvd., Pittsburgh, Pa.

NEWVILLE, J. R.
Civil Engineer,
1127 W. Wash. Blvd., Los Angeles, Calif.

NICHOLS, CHESTER L.
Rear Admiral, U.S.N. (Ret.), Director,
Int. Hydro. Bureau, Monte Carlo, Monaco

PARRISH, DUDLEY T.
Consulting Engineer,
202 Press Bldg., Johnson City, Tenn.

PATINO A., JOSE
Topographer, Geological Department,
Texas Petroleum Co., Bogota, Colombia

PEAKE, E. R. L.
Brigadier, Chief, Map Section,
I.C.A.O., Montreal, Quebec, Canada

PEREZ, LAWRENCE
Professor of C. E., Penn. State College,
255 Woodland Drive, State College, Pa.

PFAU, A. L.
Architecture, Civil Engr., Surveys,
1100 3rd St., N., St. Petersburg, Fla.

PHILLIPS, JOHN O.
Lt. (j.g.), U.S.C. & G.S., 29th Engrs.,
c/o P. M., San Francisco, California

PIPPIN, RALPH R.
Private Surveyor,
214 Blue Mountain Road, Anniston, Ala.

PONTE, J. RAF. MARTINEZ
Ingiiniero Civil,
P. O. Box 1706, Caracas, Venezuela

POTTS, JOHN C.
Asst. Dist. Engr., Potomac L. & P. Co.,
Route #1, Inwood, West Virginia

PRIMROSE, WILLIAM H.
Land Surveyor,
Relay, Maryland

PRITCHETT, NORMAN M.
Location Engineer, State Roads Comm.,
108 E. Lexington St., Baltimore, Md.

BASSMAN, EMIL C.
Attorney, General Land Office,
1304 Austin St., Wichita Falls, Texas

REDLON, JOHN A.
Dist. Toll Engr., Pacific T. & T. Co.,
731 S. Flower St., Los Angeles, Calif.

RICARDEZ, MIGUEL
Lt., Serv. Geog. del Ejercito, Mexico,
c/o U.S.C. & G.S., Washington, D. C.

RICHMOND, ADDISON E.
Assoc. Prof. of C.E, Howard University,
2401 6th St., N.W., Washington, D. C.

RIEDESEL, G. A.
Professor, Civil Engineering Dept.,
University of Idaho, Moscow, Idaho

ROELOFS, R.
Professor of Geodesy, Delft University,
Delft, Netherlands

ROSENBAUM, C. R.
Lt. Col., Hq., Antilles Department,
APO 851, c/o P. M., Miami, Florida

ROSENBERGER, RAYMOND JOYCE
Civil Engineer,
509 Cumberland Ave., Chevy Chase, Md.

ROSNER, RAYMOND J.
Engineering Aide, U.S.G.S.,
1031 N. Garfield Street, Arlington, Va.

SALERNO, JOHN
Mathematician, U.S.C. & G.S.,
530 Lincoln Ave., Brooklyn, New York

SALISHEV, K. A.
Professor, Knijnij Otdel Akad. Nauk,
Ul. Kropotkina 16, Moscow, U.S.S.R.

SALZER, THEODORE
General Manager, David White Co.,
315 W. Court St., Milwaukee, Wisconsin

SALZMAN, M. H.
Photogrammetrist, U. S. Hydro. Office,
56–B Crescent Road, Greenbelt, Maryland

SCHICK, LAWRENCE E.
Col., Head, Dept. Mil. Topo. & Graphics,
U. S. Military Academy, West Point, N. Y.

SCHINKEL, PETER W.
Grady County Surveyor,
R.F.D. #3, Cairo, Georgia

SCOTT, RONALD F.
Plan. Engr., Tenn. State Planning Comm.,
Box 34, Johnson City, Tenn.

SEVIAN, VAHE JOSEPH
Head of Survey Dept., Govt. of Iraq,
Karadat Maryam 5/2/41, Baghdad, Iraq

SHAW, EDGAR M., JR.
Geodetic Engineer, Army Map Service,
Spencerville, Maryland

SHOFNOS, WILLIAM
Mathematician, U.S.C. & G.S.,
Washington, D. C.

SIME, KENNETH T.
Chief Engineer, Air Survey Corp.,
1111 Flower Ave., Tacoma Park, Md.

SIMMONS, THOMAS L.
Registered Surveyor, Republic Steel Co.,
1505 Tuscaloosa Ave., Gadsden, Alabama

SIMPSON, ARTHUR WINFIELD
Civil Engineer,
C. E. Wright Bldg., Sacramento, Calif.

SMITH, ALBERT G.
Civil Engineer, Maps & Surveys Division,
TVA, Elizabethtown, Tennessee

SMITH, W. P.
Major, Directorate of Colonial Surveys,
Bushy Park, Teddington, England

SNEDDEKER, ROBERT C.
Instrument Man,
236 E. Courtland St., Philadelphia, Pa.

SOUTHWORTH, ALFRED M.
Surveyor, Shell Oil Co.,
Box 2099, Houston, Texas

SPENCER, JOHN W. H.
Chief, Comp. Sec., Geod. Div., A.M.S.,
306 S. Glebe Rd., Arlington, Virginia

STONEMAN, WALTER G.
Inter-American Geodetic Survey,
Box 2031, Balboa Hts., Panama Canal Zone

STROEBEL, HENRY J.
Civil Engineer and Surveyor,
2101 Marlowe Avenue, Lakewood, Ohio

STUART, DONALD G.
Geodetic Engineer, Army Map Service,
3446 Oakwood Ter. N.W., Wash., D. C.

SWIFT, JOHN L.
Jr. Hwy. Engr., Connecticut Hwy. Dept.,
R.F.D. #2, Madison, Connecticut

TAIT, JAMES G.
Officer, Malayan Survey Department,
Kuala Lumpur, Malaya

TARAPOREVALA, JEHANGIR A.
Prof. of Applied Mech., Col. of Engrs.,
Poona 5, Bombay Province, India

TAYLOR, LESLIE S.
Engineer and Surveyor,
618 Main Street, Clarion, Pennsylvania

THOMMEN, LOUIS A.
Division Engineer, Shell Oil Co.,
3706 82nd St., Jackson Heights, New York

THOMPSON, HARRY F.
Photogrammetrist, U. S. Hydro. Office,
4 Beechbank Rd., Silver Spring, Maryland

THURSTON, ROY F.
Topographic Engineer, U.S.G.S.,
10311 Cherry Tree La., Silver Spring, Md.

TIBBOTT, EDWARD W.
Associate Geodetic Engineer,
U. S. Geol. Survey, Washington, D. C.

TOOLE, W. R.
Civil Engineer,
Bureau of Standards, Washington, D. C.

TREADWELL, T. K., JR.
Lt., U.S.N., U. S. Hydrographic Office,
USS Tanner (AGS–15), c/o P. M., N. Y.

TREMAINE, R. D.
Surveyor, Malayan Union and Singapore,
Kuala Lumpur, Malaya

TYSON, JAMES L.
Civil Engineer, Town of Bourne,
Buzzards Bay, Massachusetts

ULLOM, MELVIN R.
Hydrographer, U. S. Hydrographic Office,
618 Beverly Drive, Alexandria, Virginia

VALENCIA, LUIS F.
Photogrammetric Engineer,
Carrera 19, No. 51–68, Bogota, Colombia

VERSTELLE, JACOBUS TH.
Engr., Hydro. Office, Royal Navy,
The Hague, Badhuisweg 171, Holland

WAHAB, HASSOUBI ABDUL
Asst. Engr. in Chge., Control Surv. Sec.,
Div. Gen. Irrig. & Surv., Baghdad, Iraq

WEBB, HARRY R.
Photogrammetric Engineer, U.S.G.S.,
5644 N. 5th St., Arlington, Virginia

WHITAKER, RICHARD E.
Asst. Topo. Engr., U. S. Forest Service,
Box 353, R. 3, Alexandria, Virginia

WHITE, HENRY R.
Civil Engr., E. I. DuPont de Nemours,
12502 Nemours Bldg., Wilmington, Del.

WILLETT, JAMES H.
Geodetic Engineer, c/o U. S. Military
Attache, Havana, Cuba

WILLS, GEORGE A.
Land Surveyor,
116 Park Ave., Takoma Park, Maryland

WITHERSPOON, JOHN F.
Major, Engineer, Hq., Antilles Dept.,
APO 851, c/o P. M., Miami, Florida

WOODBURY, ROBERT L.
Registered Land Surveyor,
52 Holmes St., Needham, Massachusetts

YOUNG, GEORGE F.
Civil and Landscape Engineer,
P. O. Box 683, St. Petersburg, Florida

REINSTATEMENTS

BURNS, JOSEPH P.
Photogrammetric Engineer, U.S.G.S.,
5518 Wilson Blvd., Arlington, Virginia

HINELY, J. A.
c/o Jack Ammann Engineers,
829 N. St. Mary's St., San Antonio, Texas

MARR, LAWRENCE C.
U. S. Forest Service,
1005 16th St., South Arlington, Va.

SCALES, WALTER P.
Photogr. Engr., Hq. Caribbean Air Comd.,
APO 825, c/o P. M., New Orleans, La.

WUPIO, FRANS A.
Topographic Engineer, U. S. Geological
Survey, Sacramento, California

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* * *

Geomagnetism May Guide Homing Pigeons

ARE AVIATORS about to take lessons in navigation from birds, as they originally took lessons in flight and soaring? Are ornithologists about to learn how homing pigeons find their way back home, and how migratory birds hold to a true course on night flights?

These questions are raised anew by a report given at the General Electric Forum, by Prof. Henry L. Yeagley of Pennsylvania State College, on the curious behavior of homing pigeons under his care during experiments for the Army Signal Corps.

Taken west of a certain midway point, the birds always flew to one spot in the state of Nebraska, instead of back to their home loft. Geophysical investigation showed that this western spot possessed the same intensity of earth magnetism, and also moved at the same rate as the earth turned on its axis.

Prof. Yeagley suggests that pigeons, perhaps birds in general, can sense these two things that we human beings do not feel, and that when taken away from home they fly in the direction that takes them towards the combination of geomagnetism and earth-spin to which they are used. They probably do not feel the earth's magnetism directly, he thinks, but do perceive differences in their own electrical state induced by flying across changing lines of magnetic force.

If Prof. Yeagley's hypothesis is valid, it might help explain a number of reported anomalies in bird behavior, such as the reported confusion of homing pigeons when in the neighborhood of radio towers, their inability to orient themselves when small but strong magnets are fastened to their legs, and the wild breakup of flights of ducks when radar beams were "squirted" at them by wartime experimenters.—*Science News Letter,* August 30, 1947.

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